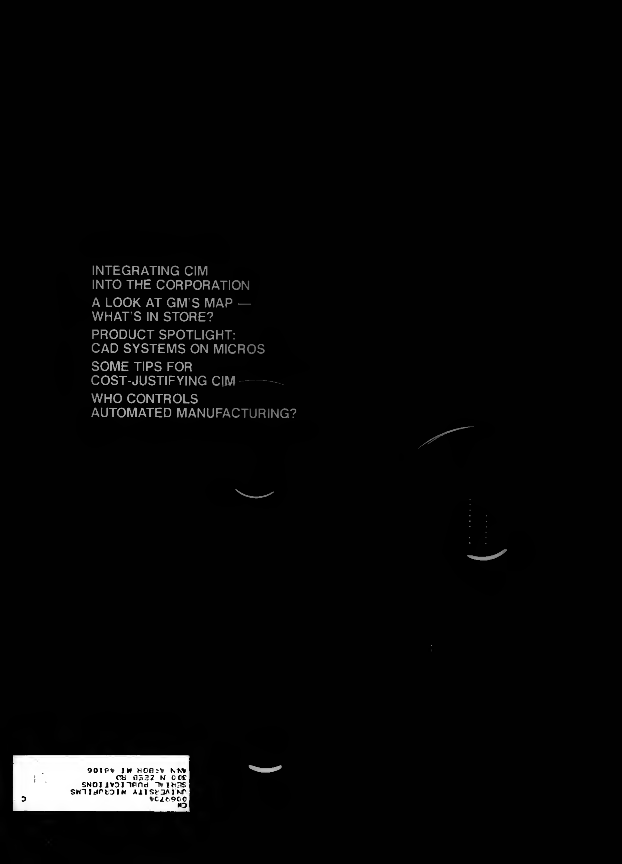

INTEGRATING CIM
INTO THE CORPORATION

A LOOK AT GM'S MAP —
WHAT'S IN STORE?

PRODUCT SPOTLIGHT:
CAD SYSTEMS ON MICROS

SOME TIPS FOR
COST-JUSTIFYING CIM

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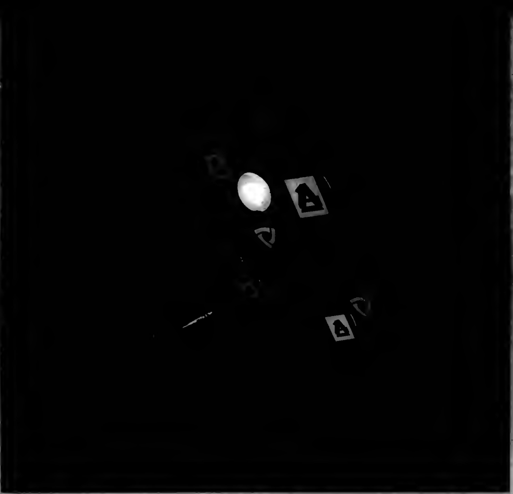

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COVER PHOTO BY BRUCE DE BOER

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The New Cincom's Business CONTROL™ Systems are appropriately named. That's because they deliver the *control* you need to optimize production, reduce costs, and improve profits.

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Editorial

Blue Collar for Big Blue?

In the eyes of the computer industry, the factory floor represents an area of virtually untapped purchasing potential. Almost all parts of the manufacturing arena have withstood the onslaught of computers, particularly of integrated computer systems. Now that the assault on the desktop has slowed, the fight for the factory may be about to begin.

Ten years ago, computers as tools for white-collar workers was an unheard-of idea. Recent activity in that area, however, has been nothing short of legendary, both in the form of technology introduced by the vendors and in the thirst for computing capacity shown by the new user groups. Even as the office market is evolving (and at the moment softening), vendors are sniffing out new and unclaimed territory, which is almost certain to be the factory floor.

Although automation is certainly not a new idea in the manufacturing environment, most systems in use today are assembly line or stand-alone. The computer revolution/evolution that swept up the office worker yesterday is heading straight on for the factory worker today. Computer-aided design and manufacturing, manufacturing resource planning, robotics and the new buzz word, computer-integrated manufacturing, will not happen overnight, however. Factory automation and integration will be subject to the same waves of technological advancement and user demand that carried along office automation and the microcomputer phenomenon. In the meantime, vendors are working toward a long-range goal of automating the factory and then tying it into corporate systems linked to offices and the data center.

Notwithstanding that this will be a long-term conversion and persuasion effort, computer makers are beginning to gear up for this new market. And even as the stampede is set to begin, the industry is wondering (and worrying about) how powerful a factor IBM will become.

In a recent speech marking Honeywell, Inc.'s centennial, James Renier, Honeywell vice-chairman, summed up the hopes of many other computer vendors when he predicted that IBM will not be able to hold sway over the industrial segment of the marketplace to the same extent it has over the other computer markets. In the meantime, vendors are waking up to this new market, reassessing resources for the factory, beginning product development and market strategy and trying to jump in before IBM — their seemingly eternal nemesis — gets there first.

None of this will happen overnight, but the seeds have been planted. Now we can wait and watch the rush for positioning and users can hope to take advantage of the product harvest.

Ann Dooley

Insider

A Better Cost Cutter

By Adam S. Zais

Manufacturing enterprises are beginning to realize that information automation is a better cost cutter than production automation. This will remain the primary driving force behind this fast-expanding market.

Computer-based manufacturing planning and control systems have finally shed the image of being a technology that is better in theory than in practice. Manufacturing resource planning (MRP II) is not only a hot topic, it is fast becoming a vital topic if manufacturing enterprises are to survive. The question many companies now face is when — not if — a system will be implemented.

Market shipments are growing at a compound annual rate of 37.4% through the end of this decade. Nearly 51% of the domestic manufacturing plants will have installed some form of manufacturing information system by 1990, according to a recent research report by International Data Corp.'s Computer Integrated Manufacturing Service. This figure represents a conservatively estimated investment of more than $16 billion in the next five years.

The long sought-after integration of manufacturing and design within manufacturing operations — sometimes called computer-integrated manufacturing (CIM) — is taken a step closer to reality with the development of interfaces designed to link design and manufacturing systems. These links are typically being established between either MRP II or data collection systems and the product design data base.

The introduction of increasingly powerful microcomputers has created a market for smaller, less expensive and more easily implemented and managed systems. In fact, the microcomputer segment of this marketplace is showing the most rapid growth as a heretofore unserved end-user — the small manufacturer — is jumping on the manufacturing information system bandwagon.

There has been a tremendous move away from in-house development — "made" systems — toward packaged software.

The value of the software content of the total system sale is rising. In 1982, the software percentage in the average system sale was 13.5%; in 1984, that percentage had reached 27%. As the average percent value of software content rises, the average value of the total system is dropping at a rate of approximately 6% to 7% compounded on an annual basis. By factoring this out, a total system (hardware and software) that costs $400,000 in 1984 will cost $250,000 in 1990.

Many available systems offer vastly improved software capabilities and a greater degree of module integration. This is transparent to the user who sees only a whole system. These systems more accurately reflect the manufacturing organization's real day-to-day needs by offering developments such as the following:

- On-line — Users have access to the system through transaction terminals or linked micros.
- Real-time — The system supports the user in his time frame, not in a batch mode.
- Net-change — The system continuously updates itself following every transaction; also not a batch mode of operation.

Developments such as these enable users to distribute specific application and information requirements to areas of the plant or office on an as-needed basis, while simultaneously effecting a data base integration strategy (for example, linking the shop floor to the front office to the engineering/design staff).

Manufacturing is increasingly an information-driven activity. Manufacturing information systems are, essentially, information-gathering, decision-making and business-planning automation systems that utilize the abilities of the computer to optimize the use of information in an automated organization.

The philosophy of present-day MRP II systems offers a blueprint for companies to begin designing a single information system that integrates financial, manufacturing, engineering and administrative applications under data base technology. The corporate information management solution will mirror this structure on a much larger distributed scale. This enterprise-level data base system will be a logical but physically linked group of data bases, not one gigantic machine. A heterogenous distributed data base system implementation topology will be the lasting CIM design in the factory of the future.

■

Zais is program manager, Computer Integrated Manufacturing Service, for International Data Corp. in Framingham, Mass.

dB
BY RICH TENNANT
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OH THE DAMN THING WON'T WORK FOR NOTHIN'.
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YEAH, AND THAT DIDN'T WORK EITHER.

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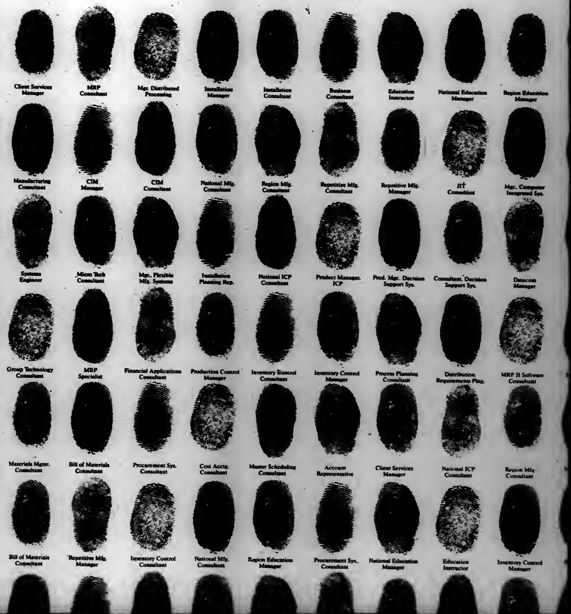

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Q&A

Jim Stifler is director of Industrial Automation Marketing at IBM. Computerworld Focus *talked with him about IBM's expanding role in computer-integrated manufacturing (CIM).*

IBM has been criticized in some quarters for not actively aiming a more aggressive marketing strategy at the factory floor but instead concentrating almost exclusively on management information systems [MIS]. Do you think that's valid?

No. A lot of information is coming from IBM systems that people in manufacturing use today — applications attuned to production scheduling, inventory, bills of material, graphics and so forth. The fact that we've taken our Personal Computer technology and ruggedized it to use in the harsh environment of manufacturing represents an interest on our part to expand the use of IBM systems in the manufacturing area.

Manufacturing seems to have grown in pockets of automation distinct from each other — the factory floor, manufacturing resource planning [MRP], computer-aided design [CAD] and MIS. Do you see IBM tying these isolated areas together?

Customers are certainly asking for more integration of these manufacturing components. Companies spending money on factories are asking to have the planning system, which has traditionally been in the data processing arena, tied very closely to what's going on in the plant on a minute-to-minute basis. In the past, people may have been satisfied with overnight reports.

Today, however,, with new manufacturing technologies, with flexible assembly or flexible machining operations, you really need access to things like scheduling, bills of material and parts data. This means MIS will be playing a larger role because MIS has traditionally been the controlling factor in planning systems. Planning has a major impact on purchasing, shipping and receiving, accounting, cost accounting and order entry — all of those things that drive manufacturing.

At the engineering level, we're seeing that if customers are handling numerical control [NC], for example, they want to have a terminal doing functions similar to those of an IBM Industrial or Personal Computer — they want to be able to look at a drawing on a screen and also use that same system to inquire into a bill of material, specification files and tooling and then be able to download the actual NC instructions into that device and drive the NC tool. When you tie all those requirements together, the result is a device like an industrial computer that, for less than $10,000, has the ability to get at the planning data as well as the graphics and NC data — basically a universal workstation.

Where should the focus of CIM be placed in a user's organization?

IBM's view right now is that CIM is something customers build. No single vendor, to my knowledge, can now provide CIM in total.

Customers really need to have a plan for product strategy, and they need to understand what will drive that product strategy to make them more competitive in their particular markets. Depending on the industry, customer competitiveness hinges on factors such as better planning, improved order entry, the way customers participate in their specific markets, their market share and customer service. It can also come from something more directly product-related — something like CAD, for instance, that can allow customers to be more competitive because they can get their designs out faster than other manufacturers. Customers want to sit down with us and start planning CIM from any one of these areas. What they want from us is the integration of communications, data and cross offerings of products in all CIM areas.

What do you see as the major obstacle in implementing CIM?

Getting a commitment from high-level management to agree to the changes in a business that CIM warrants in order to become more productive.

Too many of us in organizations tend to delegate problems to lower levels and order them to be fixed. CIM has to involve top-level executives directly because it involves so many areas within the corporate structure. Many of those business procedures still used today to justify corporate investments — decisions based on short-term; payback considerations — just can't be applied to something involving the resources and long-range planning of CIM. Resistance by top management to making commitments to these long-term goals will be one of the key inhibitors to CIM for the next five years.

IBM recently entered into OEM agreements with Calma Co., Computervision Corp., McDonnell Douglas Automation Co. and other CAD systems vendors. Do you see that increasing?

Yes. In the industrial environment, we've opened relationships with a number of what we call industrial distributors, organizations that have traditionally sold devices such as programmable controllers and instrument packages to manufacturing and process people. These people now carry our computer line.

We've also opened a number of OEM agreements with manufacturers of programmable controllers, machine tools and other industrial instrumentation, and we're expanding our traditional value-added remarketer channels. Because the technology is moving so fast, many companies that once built their own hardware now find their sales volumes can't justify the necessary research and development to bring state-of-the-art technology to the market. Such turnkey systems vendors are finding it easier to buy hardware and add to it.

What area within IBM would guide a customer toward CIM?

We have an organization called the Industrial Sector, which is part of our marketing group. Within the Industrial Sector we have a number of specialists who work with our branch-office people. A customer can have one of his marketing representatives or industry specialists bring in someone from our Industrial Sector group to discuss IBM's industrial products and planning. We also have demonstration centers to show our products and analyze what the customer ought to do first. Beyond that, we also provide application transfer teams, also part of the Industrial Sector, which conduct joint studies between IBM and a customer concerning the customer's needs in CAD/CAM, industrial automation and business planning.

Letters

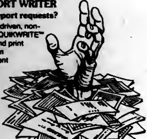
Who Really Pays Hacker's Phone Bills?

The Q&A clip from the March 20, 1985 issue of *Computerworld Focus* recently appeared in my in-basket, and I felt that in order to assert the innocence of the Tandy Corp. Model 100 portable computer, I should respond to the column.

The interview with the computer hacker who uses his knowledge to break through computer security to do such harmless things as "getting secret codes so I can make free long-distance calls" reflects an attitude adopted by other dishonest people to minimise their crimes. Most of us are astute enough to realise the costs of his "free" calls are passed on to the rest of us consumers.

I can't help but flinch when I see an excellent product like the Model 100, which has proved to be an outstanding performer in so many applications, used for dishonest purposes.

Linda Miller
Marketing Information Department
Radio Shack
Tandy Corp.
Fort Worth, Texas 76102



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In the News

Costly Gear, Bad Training

Companies that invest large dollar amounts in hardware and software to solve their problems are going to be disappointed; "only people run businesses," according to Al Lanick, a consultant with Advanced Systems, Inc., a Chicago-based management consulting firm specializing in manufacturing training.

Lanick stressed the importance of training to support the implementation of elaborate and costly manufacturing systems. Reaction has ranged from total acceptance to total rejection. With the latter, an attitude of "Why should I invest more money when I'm buying all these expensive systems?" predominates. But Lanick contends that the only way to make the systems successful is to provide formalized training. Good training also allays worries about job security and helps build the confidence workers need to ensure good implementation.

Lanick cited the differences in training methodologies for management information systems (MIS) personnel and for manufacturing staff. "Unlike MIS, which has had a steady growth of professionals and a growing discipline in terms of how to use systems, manufacturing to some extent has lagged in adopting some of the new technologies," he explained.

Most effective training is done on an inhouse basis using a facilitator in a small group setting, according to Lanick. The facilitator, usually a person from the plant or facility, understands the business and speaks the jargon of the industry.

Two training audiences exist, Lanick said. The first, top management, is responsible for making sure the system does what it is billed to do; the second consists of those who have direct line responsibility for actual implementation.

Although the cost of comprehensive training varies, company size is not as important as the length of time the training might take. "I have seen $10 million companies that have spent $50,000 to $70,000 on manufacturing education, and much larger companies that have spent less," Lanick added.

No Prime Cuts Here

Each day seems to bring more bad news about layoffs, cutbacks, hiring moratoriums and "common vacations" from computer and peripherals manufacturers. The slowdown is affecting companies from the Pacific's Silicon Valley to the Atlantic's Route 128.

It was refreshing to hear that Joe M. Henson, president of Prime Computer Corp. in Natick, Mass., expects Prime to hire 1,000 additional people this year. In his address at the annual stockholders' meeting in Boston on May 15, Henson said most of the jobs will be in sales, research and development and computer-aided design and computer-aided manufacturing (CAD/CAM).

A company spokesman pointed out that the CAD/CAM market itself is growing at about 30% to 40% a year and said Prime will certainly meet or exceed those figures. Last year [CAD/CAM] accounted for about 16% to17% of Prime's total business at a growth rate of about 35%.

Although representatives from Prime would not divulge exact numbers, Bob Sanches, manager of human resources, CAD/CAM and Workstations/Terminals Group at Prime, said the increases in numbers of jobs could approach 20%. All of the CAD/CAM positions will be in the Natick/Framingham, Mass., locations.

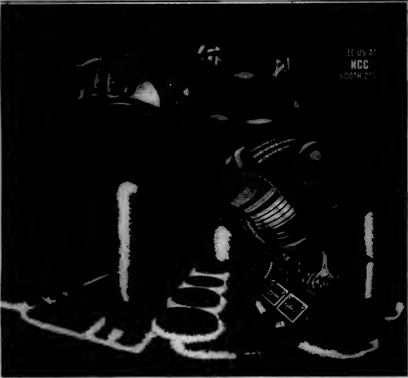
OSI Demo in November

Boeing Computer Services Co. of Vienna, Va., recently announced it will join with General Motors Corp. in cosponsoring a multivendor demonstration of the International Standards Organisation's (ISO) Open System Interconnect (OSI) protocols.

The Boeing/GM demonstration will take place at the Autofact Factory Automation trade show in Detroit in November. The joint demonstration will feature interconnected OSI 802.3 and 802.4 networks via the Internet protocol, layer 3 of the OSI reference model. According to Laurie Bride, manager of network technology at Boeing's corporate headquarters in Seattle, Wash., participants include Intel Corp., AT&T Information Systems, Inc. and Honeywell, Inc. on both 802.3 and 802.4; Kodak Corp., Motorola, Inc. and Sun Microsystems, Inc. on 802.3; and IBM, Hewlett-Packard Co., Digital Equipment Corp. and Allen Bradley Co. on 802.4. In addition, the demonstration will operate with the OSI Transport, Session and File Transfer protocols, levels 4, 5 and 7 of the reference model.

Prior to the November event, Boeing has invited several major computer manufacturers to participate in the creation of an OSI testing center at its headquarters in Bellevue, Wash. Robert L. Dryden, president of Boeing Computer Services, said the testing center will be an open facility and encourages users to visit.

Doane Perry, editor of "Communications and Distributed Resources Report" for International Data Corp. in Framingham, Mass., said Boeing Computer Services is expected to grow but the aircraft industry may not. If that happens, the computer arm of Boeing could be a force in the industry, much like H. Ross Perot's Texas-based Electronic Data Services recently bought by General Motors. "Boeing Computer Services has always been quite innovative and resourceful," Perry concluded.



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In Brief

DALLAS — Intel Corp. of Santa Clara, Calif., and Westinghouse Electric Corp. of Pittsburgh, Pa., announced they had signed a letter of intent to jointly develop software products to conform with General Motors Corp.'s Manufacturing Automation Protocol (MAP) specifications.

Under the agreement, announced at a recent MAP users group conference, MAP software developed by the two companies will become the exclusive property of Intel, and Westinghouse will retain a royalty-free license to use and distribute MAP software with the sale of Westinghouse hardware products.

NORWALK, Conn. — During the next 10 years, U.S. industry will purchase a total of about 200,000 industrial robots, according to a report issued by International Resource Development, Inc. (IRD). IRD also predicted that nearly 60,000 of these robots will be equipped with vision capabilities enabling them to operate with more flexibility and safety than blind robots.

The IRD report said that although prices for vision-capable robots, currently averaging about $150,000 each, will fall rapidly, buyer resistance will likely remain for several years because of reliability problems and design bugs plaguing today's robot vision systems. IRD added, however, that recent advances in signal processing semiconductor chip sets have helped boost the performance of vision-capable robots, and even greater performance improvements are expected over the next few years.

The report also mentioned that, contrary to some industry experts, U.S. robot vendors do not seem likely to be displaced by Japanese vendors. Further information is available from IRD, 6 Prowitt St., Norwalk, Conn. 06855.

FALLS CHURCH, Va. — The American Production and Inventory Control Society (Apics) has announced publication of its 1985 Spring Seminar Proceedings, "Computer Integrated Manufacturing and Flexible Manufacturing Systems." Included in the proceedings are articles dealing with effective planning for technological change, management of implementation of advanced systems and price and performance evaluations of flexible manufacturing systems.

The 346-page book, order number 40666, costs $20 from Apics Publications Order Department B, 500 W. Annandale Road, Falls Church, Va. 22046.

MADISON, Ga. — SEAI Technical Publications has announced two new publications on computer technology and manufacturing.

Artificial Intelligence Applications for Manufacturing is a review of the fundamentals of artificial intelligence with a description of more than 120 commercial products applicable to manufacturing. The 194-page book is available for $110.

The 1985 Handbook of Manufacturing Software is divided into two parts: Part I reviews the fundamentals of computer technology and presents a description of major application areas; Part II includes cost, computer compatibility and availability for more than 500 software programs applicable to manufacturing and industrial processes. The listing includes programs for mainframes, minicomputers and microcomputers. Computer applications for robotics are also covered. The handbook sells for $197.

Both books can be ordered from SEAI Technical Publications, P.O. Box 590, Madison, Ga. 30650.

CHELMSFORD, Mass. — Apollo Computer, Inc. has signed with Siemens AG of West Germany an OEM contract projected to be worth $100 million over the next three years. Under the agreement, the Power Engineering and Automation Division of Siemens will purchase Apollo's Domain workstations for computer-aided design use in computer-integrated manufacturing networks, computer-aided software engineering and expert systems.

NEW YORK — The Dun & Bradstreet Corp., parent to McCormack & Dodge Corp. in Natick, Mass., recently announced the acquisition of the manufacturing software business of Rath & Strong Systems Products, Inc. (RSSP), the Dallas-based developer of manufacturing information software systems. RSSP will become a unit of McCormack & Dodge.

RSSP's software product, Production and Inventory Optimization System (Pios), is an on-line, real-time manufacturing control system made up of eight modules that can be purchased and implemented separately. McCormack & Dodge will incorporate Pios into its Millennium Series of business application software products, thus expanding McCormack & Dodge's software offerings into the manufacturing environment.

"The Rath & Strong product is a pretty well respected product, but it's a big manufacturing system in terms of its capabilities. It may be difficult for McCormack & Dodge to move [Pios] through the mid-size manufacturers that it does a lot of its business with," Damian Rinaldi, director of the Software and Services Information Program at International Data Corp. in Framingham, Mass., explained. Rinaldi also said the integration task will be fairly extensive, but "McCormack & Dodge has shown remarkable patience in terms of its long-term strategizing. The choice [of Pios] makes real good sense for the long term; in the short term, I don't know how many successes they're going to have with the product," he concluded.

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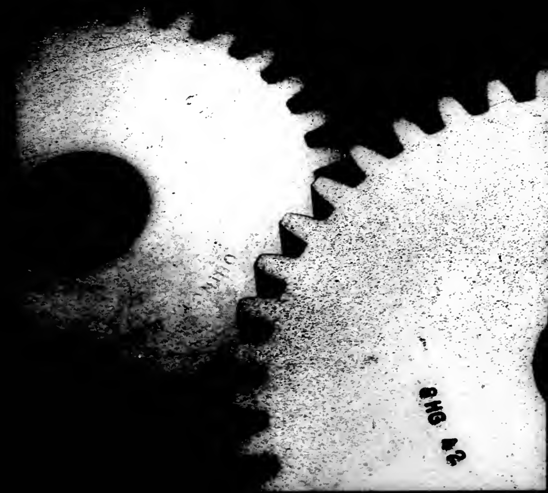
CIM Implementation—A Top-Level Priority

By Ray L. Dicasali



[illegible] news [illegible] doing to hear [illegible] U.S. manufacturing [illegible] trated. It is as if the world [illegible] on its ear and [illegible] would stop the drain of our productivity, our market and our profits. John Naisbitt elevated this trend to the status of megatrend and predicted that the U.S. manufacturing base will continue to erode as production moves offshore. Some now operate as though this process is a foregone con- [illegible]

[illegible] We [illegible] answer. We [illegible] the right [illegible]. We know the [illegible] ball, but the rules have changed. We've entered a new era in world manufacturing. The competition is stiffer, the life cycle of products shorter and the margins narrower. In addition, the continuing strength of the U.S. dollar has aggravated the [illegible]

[illegible] foreign [illegible] competitive [illegible] world [illegible] larger [illegible] also [illegible]

Some manufacturers [illegible] significant strides [illegible] to gain greater [illegible] operations through deliberate strategic planning. The result [illegible] performance in all areas [illegible] facturing operations to [illegible]

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These manufacturers have focused as much attention on planning for obsolescence as on introducing new products to the market, and they have a host of new tools to aid them.

Important advances such as robotics, computer-aided design (CAD), computer-aided manufacturing (CAM) and computer-aided engineering (CAE) have taken place in technology. Much attention is being focused on Just-in-Time manufacturing, zero inventory and optimization; flexible manufacturing and group technology are not far behind. All of this is supposed to combine to comprise the focused factory or the factory of the future.

This proliferation of technology and terminology seems at times to resemble confusing clutter. Does it make sense? What does it mean for data processing personnel?

The new term for this technology is computer-integrated manufacturing (CIM). CIM is the umbrella under which the independent pieces — CAD, CAM, group technology, robotics and so on — are organized to work together. The definition is not yet complete, but it has reached a point where several major components of CIM can be described.

CIM is computer-based, and it is hardware. It is also software. At its core, CIM is a view of the layout of the manufacturing plant from an information processing perspective. It is as much a way of managing information as it is machinery and manpower. CIM is also firmware — dedicated pieces of automation, whether robotics, CAD/CAM or automated storage and retrieval systems for materials handling.

These three components, as well as some pieces not yet envisioned, are combining to comprise a powerful new tool for manufacturing. Information drives the tool, and DP will play an increasingly larger strategic role. In 1990, U.S. manufacturers will spend $33 billion on this technology, according to International Data Corp., a research firm in Framingham, Mass. Nearly one third of that amount — a fourfold increase over the amount spent in 1984 — will go for management information systems (MIS) and materials resource planning (MRP). In spite of all the excitement surrounding CIM and what it will mean for U.S. manufacturing, however, CIM is not the goal of all this activity. The goal is competitive survival — shortened development time, reduced costs and improved quality. We must be more responsive to the market and more profitable.

This task will not be accomplished merely by throwing around corporate assets such as money and manpower, although these will, of course, be required. Capital resources alone won't get the job done. The real issue will be how well the technology is managed. The challenge of CIM is an executive challenge, and the question will be how well top management does its job.

What is called for on the front end is a clear, precise, corporate strategy for implementing CIM. Each manufacturer will have to determine what its strategy will be. Although the strategies will be different for each industry and for every manufacturer, success will hinge upon careful planning of several logical steps:

- *Prime the corporate culture for change.* In order for the implementation of a CIM strategy to be a top corporate priority, preliminary education will be required. Management must have a basic understanding of how the new technology will fit in the overall operating plan, whether the strategy calls for a completely new facility or incremental implementation of new technology. Sustained commitment to the project will be difficult without a realistic understanding of the technology and of the required time for implementation. Without top management's strong commitment, the project will face impossible barriers.
- *Clearly define expectations.* Be sure you know what problems you are trying to solve. By defining your expectations, you will establish a blueprint for making wise investment decisions. This preparation will serve you in two ways: First, you will eliminate technology that doesn't yield targeted results. Second, you will have a benchmark to guide you in a process that could take several years to complete.
- *Appoint a CIM champion.* The role of CIM project team leader is as much an advocacy role as it is a leadership role. CIM is not only a new tool, it is a new way of doing business. A CIM project needs someone to champion its cause and that person should be someone with no vested interest in old departmental divisions of authority.

The role of project team leader is a full-time job. The leader should be experienced — someone who understands the problems to be solved and who either is at board level or has board-level backing and commitment.

- *Establish a project team.* Because the project team is charged with changing the manufacturing corporate culture, it is important that the group should be a representative body and include people from all areas of the company which will be affected. It is particularly important to include people from DP, marketing, engineering, purchasing, production and finance because those people will be expected to increase efficiency and productivity with the new technology.
- *Perform a detailed environmental analysis.* This step is one of the most crucial, yet it is the step most frequently overlooked in the process of implementing new manufacturing technologies.

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   - [illegible] Public Utility/Communication Systems/Transportation
   - 70 Mining/Construction/Petroleum/Refining
   - 75 Other User ______

   Vendors
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   - [illegible] Computer/Peripheral Dealer/Distributor/Retailer
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2. **OCCUPATION/FUNCTION (Circle One)**
   - 11 President/Owner/Partner/General Manager
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   - 13 Treasurer/Controller/Financial Officer
   - 21 Director/Manager/Supervisor DP/MIS Services
   - 22 Director/Manager of Operations/Planning/Administrative Services
   - 23 Systems Manager/Systems Analyst
   - 31 Manager/Supervisor Programming
   - 32 Programmer/Methods Analyst
   - [illegible] OA/WP Director/Manager/Supervisor
   - [illegible] Data Comm Network/Systems Mgmt
   - 41 Engr/Scientific/R&D/Tech Mgmt
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   - D. Communications Systems
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3310-01

Only when you have a detailed analysis of current operations in hand will you have a clear picture of where to focus your efforts. Technology can help you solve problems, but it is not a miracle cure for bad communications, bad production flows and bad management.

One of the chief benefits of implementing new technology is gaining a fresh perspective on how you do business. In the process of performing an environmental analysis, you may discover that new technology is not necessary, at least not in the form you had initially envisioned. There may be simpler answers: For example, you might find that shortening a production line (thereby decreasing the time needed to move a product between workstations) is a better answer than installing automated handling systems.

A detailed environmental analysis is time-consuming. Nevertheless, it is not only well worth the effort, it is the foundation upon which to build your future.

Know what you want to accomplish, then look for the means to achieve it and keep it as simple as possible.

• *Identify the technology your strategy requires.* After you have a clear picture of how you currently operate and of the problems you need to address, you're ready to clearly document the specific details of your CIM strategy.

You might decide you need an integrated manufacturing control system that ties production more closely to distribution. You might find that a CAD system would greatly increase productivity, but a CAM system would have little impact. The need will be different with each manufacturer; therefore the strategy will be different.

The point is this: Know what you want to accomplish, then look for the means to achieve it and keep it as simple as possible.

• *Formalize your operating policies.* Moving from an informal manufacturing system to a formal one requires time. It's possible that 70% of the life of the project will be spent performing this task and the prior one. It's also possible that 50% of the benefit of the project will occur here as well. If the new system is to work effectively, however, you must have the proper disciplines in place to reinforce a formal approach. This is a good time tó call on the expertise of experienced outsiders — people who know not only the details of the new technology but also the nature of your business.

• *Establish working partnerships with suppliers and vendor.* A good businessman takes control of factors that are controllable and anticipates those that are not. All too often, manufacturers believe they are at the mercy of their suppliers — suppliers of materials, machinery or computer hardware and software. One of the chief goals of a CIM strategy should be to gain greater control in this area and to build working partnerships with people you must depend on.

Quality and service are becoming as important as price (and in many instances, more important) to maintain a competitive edge in the market. For the partnership to work, suppliers need to know you are as concerned about quality and service as you are about price. You need to select your partners carefully.

Can material suppliers, for example, deliver what and when they say they can? Can you monitor and track their performance? Can you furnish them with long-range visibility of your material needs? If technology is being supplied, is it applicable and proven, or is it still just promises? How does it integrate with the technology you already have? Before you invite anyone to be a partner in the success of your business, you want to know the answers to these basic questions.

• *Follow a sound, proven implementation methodology.* Can the partners supplying you with new technology offer you a proven implementation methodology? If not, you should seriously question their ability to play an active, beneficial role in your business.

• *Track and report your progress.* Whether you plan to build an entirely new manufacturing plant or a factory of the future from the ground up or plan to implement the new technology in incremental steps, you will probably need to rethink your cost-benefit analysis model.

Moving toward CIM is not a quick fix. It is a long-term project, and it requires a long-term investment strategy. Return on investment is not justified under a two- to five-year model, judging from the experience of leading-edge manufacturers already implementing CIM strategies.

One major industrial manufacturer is planning to spend $50 million over 10 years to develop a state-of-art factory of the future. Whatever your strategy calls for, be realistic about the payback cycle. If you underestimate the time it will take to see return on investment, you may undermine commitment to the project.

■

Dicaseli is vice-president of the Manufacturing Systems Division of Management Science America, Inc., Atlanta, Ga.

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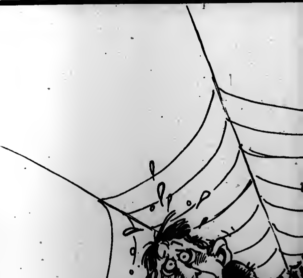
Manufacturing Networks Can Be Tricky Areas



MAP: GM's Attempt To Set Standards

By Ron B. Keil

Worldwide competition is exerting increasing pressure on the automotive industry in its own basic business — providing transportation products. To meet these challenges, General Motors Corp. has stepped up the pace of a number of programs aimed at continuous improvement in the cost and quality of manufactured products. In this process, large numbers of robots, programmable controllers and other programmable devices have been introduced into the manufacturing process, and statistical process control tools are being used to monitor "as built" quality. Accompanying this growth in the number of programmable devices has been a growth in GM's requirements in other areas. In addition to an increased need for computer support for programming, documentation and backup, the need for sophisticated communication has been outstanding. A review of some components involved will point out why GM's Manufacturing Automation Protocol (MAP) is so important. Among the areas affected are the following:

- Work force involvement has proven to be a valuable tool for GM's quality and cost-improvement effort. In an attempt to provide facts about the state of the business, employees are told GM's competitive position in relation to quality and costs. This information is

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One User Gives MAP a Try

By David C. Scott

Amid all the hoopla about computer-integrated manufacturing (CIM), most organizations have reached only a couple of concrete conclusions. First, achieving true CIM will be an evolutionary process. The last of the turnkey CIM believers has faded away, and the word evolution is appearing in nearly all articles and discussions on the subject. Second, the computing environment on the CIM shop floor will include a multitude of vendors selling computers of varying types, computer numerical control (CNC) machinery, process controllers, reliability and quality inspection and computing equipment, robots and automated material handling and storage systems.

Those who agree with these conclusions must also acknowledge the need for a flexible yet powerful communications infrastructure for the factory floor. Indeed, putting such a system in place should occur relatively early in the move to CIM because it will provide a technological foundation for factory automation.

General Motors Corp. dealt with this situation by initiating its Manufacturing Automation Protocol (MAP) effort. MAP is an attempt to develop a specification for a set of standards to allow a multiple vendor computing environment on the shop floor. Testament to the wide acceptance of the above conclusions is the fact

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communicated by video setups at numerous locations in the plant complex.

- An indirect effect on manufacturing costs has been the escalating cost of utilities. To try to control this area GM measures usage of water, gas, pressurized air, steam, electricity and other resources — often by means of computers and programmable controllers.
- GM is investigating and, in some cases, implementing asynchronous machining and assembly systems that are much more flexible than the traditional systems of the past. To facilitate flexibility, the communication requirements increase in order of magnitude.
- To protect its large investment in facilities, GM uses closed circuit TV surveillance and computerised monitoring systems to warn of fires or other dangers.
- Accounting systems, personnel systems, material and inventory control systems, warranty systems and others use large mainframe computers with remote terminals located throughout the manufacturing facility.

As the above mentioned items indicate, the need for communications in GM plants is considerable. That communications system must be able to accommodate voice, video and high-speed data. The communications network therefore becomes an integrating force for factory operations. And, of course, because the automotive industry is a highly competitive business, any communications system GM installs must be cost-effective.

GM realized in the middle 1970s that, because of its requirements for an integrated communications system and the diversity in programmable device vendors, communications standards were needed for the factory floor. Some ad hoc task forces were formed to focus on broadband coaxial cable.

In early 1980, with corporate support, the Manufacturing Automation Protocol (MAP) task force was formed and included former broadband task force members. The original MAP task force objectives were to define a MAP message standard that supports application-to-application communication, to identify application functions to be supported by the message formatting standards and to recommend low-level protocols that meet functional requirements. The task force is comprised of representatives from about 15 GM divisions and from the corporate manufacturing staff (see Figure 1).

Soon after its formation, the task force identified the International Standards Organisation's (ISO) seven-layer model for open systems interconnection (OSI) as a basis for standardized networks. Because the model specifies function rather than protocols, however, compliance with it does not ensure multivendor communication. The strength and current support of the MAP specification is its selection of existing or emerging standard protocols. All seven layers of the MAP specification will be international standard protocols. The current version of the MAP specification is 2.1. GM has committed to upward compatibility for all future versions since 2.0.

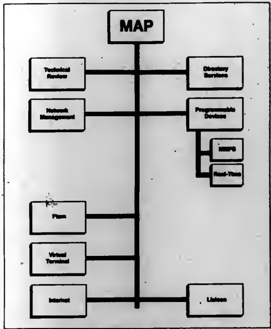

Figure 1. General Motors Corp. MAP Task Force

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GM's goal for MAP is that it become an open national standard with widespread use. The 1984 National Computer Conference demonstration took MAP a step nearer this goal.

- Layer 7, application (has responsibility of providing communication services to user programs): currently specified as a GM manufacturing messaging format standard (MMFS), the ISO common access service elements (Case), ISO file transfer and some preliminary network management and directory services.
- Layer 6, presentation: currently null.
- Layer 5, session: currently specified as the ISO session kernel.
- Layer 4, transport: the ISO transport protocol.
- Layer 3, network: the ISO connectionless network services (CLNS).
- Layer 2, data link: specified as the IEEE 802.2 LLC procedures.
- Layer 1, physical: specified as IEEE 802.4 token bus broadband.

MAP currently specifies broadband coaxial cable for the physical media in factory floor local-area networks. For several reasons, GM believes broadband is the best choice among current available media.

First, broadband coax accommodates multiple networks on the same media. Second, it will simultaneously support high-speed data as well as voice and video. A final point in support of broadband coax is that it is flexible enough to accommodate GM's rapidly changing plant requirements.

GM chose a token bus access method for factory floor local-area networks. In a token access procedure, a predetermined device generates a token and passes it around the network. A device can transmit only while it has the token. All devices listen and respond to data addressed to them. A token passing procedure is deterministic because the maximum response time can be explicity calculated. The token bus access method (IEEE 802.4) is supported by the programmable controller industry.

The layers above transport are value-added to the local-area network. MAP specifies session kernel to provide the connection establishment and management of the users. Session's dialogue management provides the application with standard mechanisms for synchronization and full-duplex and half-duplex communication. The application layer protocols provide the communications to the user program. Applications (user programs) talk about the application layer as their universe; the official term is universe of discourse.

The application layer elements specified in Version 2.1 of MAP include Case, MMFS and file transfer and access management (Ftam). Case provides connection, context switching and other services common to any user. MMFS, which was developed by GM and its vendors to provide necessary services and messaging to programmable devices, is currently undergoing a thorough review in the Electronics Industries of America's Committee 31 as Draft 1393A. A national standard should be available in 1986. Ftam provides services for file users. An application uses the services necessary for its particular function.

GM's goal for MAP is that it become an open national standard with widespread use. The 1984 National Computer Conference demonstration took MAP a step nearer this goal when it proved that a multivendor networking project can work. GM and Boeing Computer Services Co. are sponsoring another networking demonstration at the Autofact Conference in Detroit in November. At that time, Boeing's 802.3 local-area network will be connected to MAP's 802.4 local-area network. MAP Version 2.1 will be implemented. GM believes Version 2.1 finally offers a minimum set of services for an operating local-area network — a significant step.

The ultimate goal is that through standardization and proliferation, very large-scale integration chips will be developed and will drive the connection cost for each programmable device below existing point-to-point connections. GM is committed to the development and worldwide use of MAP and will seek a competitive advantage on the use of the network, not on the standards.

■

Keil is manager of communications and control systems engineering for the Chevrolet-Pontiac-Canada Group of General Motors Corp. in Warren, Mich.

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(Continued from Page 19)

that over the past two years, the MAP Users' Group has grown phenomenally and now includes representatives of virtually all of the largest U.S. manufacturers.

One of MAP's early supporters outside of General Motors was Deere & Co., the large manufacturer of agricultural, industrial, forestry and consumer equipment. Deere has often been recognised as a leader in the areas of factory automation and CIM. In 1981 the Computer and Automated Systems Association (Casa) awarded Deere's Tractor Works in Waterloo, Iowa, its first Lead Award, presented annually to a company in recognition of a leading edge implementation of CIM. Other examples of advanced automation and integration of computer-based systems can be found throughout the company.

Deere has, however, paid a high price for that integration. Up to 50% of the final costs of introducing automated processes and systems have gone to installation and integration of computerized equipment with existing systems. The bill for ongoing support of such systems from a communications and integration viewpoint has limited the advantages gained. The current direction of the CIM movement has the potential to amplify these problems because it emphasises the use of many new shop floor computing devices: powerful microcomputers and engineering workstations in an hierarchical, distributed computing environment for functions such as cell controllers, distributed numerical control (DNC), adaptive control of processes and real-time scheduling to accommodate concepts such as Just-in-Time manufacturing. These devices will be required to communicate not only among themselves but also with the various computers arriving on virtually every piece of new manufacturing equipment. Thus the rationale behind MAP is very appealing to Deere because it strives for plug-in automation and shop floor communications, basics for the realization of true CIM.

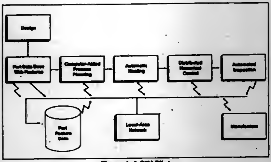

Figure 1. A CIM Pilot

To emphasize its commitment to MAP, the company incorporated what turned out to be the first manufacturing production MAP-compliant network in a CIM pilot project in 1984. The intent of the project, as depicted in Figure 1, was to demonstrate CIM by developing techniques to transform computerised designs into completed manufacturing instructions that could be transmitted directly to and from the shop floor using a DNC system. The system was to support sheet metal parts to be manufactured in a cell including a turret punch press with laser and a straight shear.

Starting with computer-based design geometry augmented by feature-type data, computer-aided process planning would develop a manufacturing plan and instructions, including a numerical control (N/C) program for each part. A nesting package on a Computervision Corp. system would then nest many of the same or different parts on the same raw material sheet and finalise a program to drive the N/C punch press with laser. Finished plans would be transmitted to a DNC host computer where they would be archived and managed. From the DNC host they could be downloaded directly to the machine controller. The need for a communications backbone, which would also need to accommodate all other emerging automation and CNC equipment in the factory, was discovered as the project planning proceeded. Local-area net technology was seen as a logical solution, and a work package to pursue a local-area net was formulated. The initial application would be the DNC system.

In May 1984, requests for proposals for a local-area network were sent to several vendors. Deere's involvement with MAP had progressed during the planning phases of the local-area network package, and the company decided to include MAP compliance as a bid requirement. Although installation of a broadband backbone and associated one-time start-up costs is more expensive than traditional point-to-point coaxial wiring schemes, the expenditure was approved because it would both save cabling dollars in future rearrangements and accommodate CIM.

The local-area net was designed and implemented by an in-house team. The broadband utility was designed by an electrical engineer from plant engineering with training from an equipment vendor. Other team members included representatives from computer systems to handle interfacing and protocol problems and from manufacturing engineering systems to address DNC and process application questions.

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The plant engineer developed a computer program that allows graphical design of cabling schemes and automatically computes signal levels and other parameters and then inserts required components (amplifiers, couplers and so on). This allows quick evaluation of feasibility and cost of several alternatives for cabling. The 3,300 feet of broadband was installed by a cable television contractor. MAP-compliant network interface units (NIU) were purchased from Concord Data Systems, Inc. and a DNC host computer was purchased from Numeritronix. The network was operational by Nov. 1, 1984.

Pilot members were excited when they compared future possibilities of using the network with their former experiences.

Attempts were then made to link the Numeritronix computer and the punch/laser machine tool's General Electric Co. 1050 controller. The problems encountered read like a Why MAP? listing. The implementation team still had to resolve incompatible protocols and speeds; only the first two layers of the MAP specification, which provide media access control (getting you on and off the network), were being implemented in the NIUs. Connections to nodes from the NIUs were RS-232 links, making the initial DNC application appear like a point-to-point connection via the broadband. The RS-232 standard provided several challenges; the various devices were using different pin configurations. Perhaps the biggest stumbling block was the lack of complete communication specifications; as a result, data scopes were needed to figure out exactly what speeds, protocols and other communication parameters were being used.

After nearly a month of uncovering and solving such problems through both software and hardware, a successful link between the DNC host and the first machine was completed. Having learned from the first machine, the team successfully connected the second machine, the shear, much more quickly even though it encountered many of the same problems. NIUs were connected to Computervision and Digital Equipment Corp. VAX systems and, using the routing capability of the NIU, connections were made to an Okidata Corp. printer, a Sun Microsystems, Inc. engineering workstation and several types of terminals. The cell was released to production Feb. 1, 1985.

The consensus among pilot participants was that it was a very worthwhile learning experience. The critical need identified was that more complete and detailed specifications regarding communication requirements should be provided to vendors and received from vendors so that debugging could be more direct. Pilot members were excited when they compared future possibilities of using the network and the ease of adding additional devices with their former experiences stringing additional cables for each new or relocated device. Even though device connection was usually straightforward, protocol and messaging problems reinforced the desire for completion and commercial offerings of the upper layers of MAP, which will address these areas. Additional applications that would take advantage of the video and audio capabilities of the broadband, (for example, plant security video, interactive training of operators and video teleconferencing) are already being discussed. Plans are being finalized to extend the network to accommodate an additional application — a DNC-like system to download computer-optimized control parameters to a series of resistance welder controllers.

Perhaps the largest remaining challenge is planning for and managing the shop floor communications, computing and

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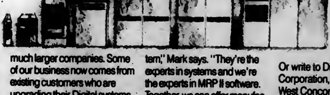

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automation directions to accommodate CIM in a large decentralised company such as John Deere. If experiences such as those in the pilot are to be worthwhile, they need to be shared and incorporated in future efforts. Deere has taken several steps to address this challenge:

At the corporate office, a CIM systems organisation was formed with computer-aided design and manufacturing (CAD/CAM) systems departments within it. CAM systems responsibilities include factory automation planning, factory local-area networks and MAP activities. A Shop Floor Computer Communications and Control (SFCCC) Users' Group has been formed under this group's leadership. A steering committee formed to coordinate and provide input to the overall group has members from corporate manufacturing engineering, computer systems, quality and reliability engineering and CIM systems. This general group is composed of factory representatives from the same disciplines as the steering committee. As in the pilot, each unit is encouraged to form a core shop floor communications team with members from plant engineering, computer systems and manufacturing engineering systems. Similar to the GM MAP Users Group experience, response to the SFCCC has been very enthusiastic; all units have experienced the above problems as individual machines and cells have been installed.

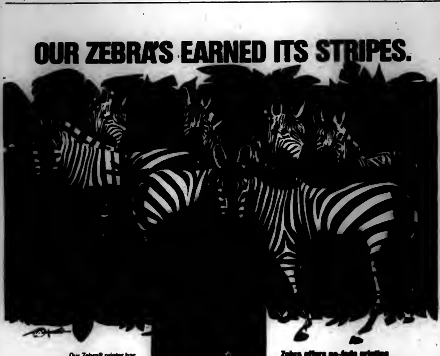
The role of the SFCCC is threefold: education, coordination and direction. At the overall meetings, educational segments on topics such as MAP are included with unit updates on experiences and current problems and issues being faced. Members are asked to share lists of vendors, contacts, informational sources and any data that may be useful to others. As issues are brought to the surface by the group, plans are formulated for their resolution in an effort to provide future direction.

At the first general meeting, users decided to form three interim working groups to develop guidelines for the three primary issues identified during the meeting. The first group will develop boilerplate specifications for inclusion in shop floor equipment specifications that will deal with the desired capabilities of the computer control. It will cover physical and electrical characteristics, protocols and general capabilities required to integrate the equipment into an overall CIM system. Basic examples are upload and download commands and terminal mode. The application layer of MAP using the EIA-1393 specification will be the ultimate answer when complete. The second group will work on guidelines for the communication utility and physical cabling schemes, including plans on how to evolve from current systems (for example, PBX) to the ultimate broadband for MAP in a cost-effective way. The final group is addressing flow and placement of data in the evolving distributed hierarchy on the shop floor.

The largest remaining identified need is training at all levels. To address this, outside training vendors are being contacted to provide courses ranging from overviews of local-area networks to MAP to detailed broadband engineering instruction. Extensive contacts are being maintained with vendors of local-area networks, computer equipment and controllers to obtain education on their directions and products and to encourage their participation on future pilot projects stressing MAP.

CIM will become a reality on a broad scale within the next few years. If companies are to be ready, however, foundations must be laid now. The communications schemes for the shop floor are essential, and the MAP approach offers a very attractive alternative with an expanding support base from users and vendors. Rather than just waiting for MAP to happen, companies that hope to realize the CIM potential must now begin planning and learning through activities such as pilots and users groups. The benefits are tremendous.

Scott is division manager, Computer-Aided Manufacturing Systems for Deere & Co. in Moline, Ill.



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But How Do You Cost-Justify It?

[illegible]

In that article, Hayes and Abernathy concluded that "the key to long-term success, even survival, in business is what it has always been — to invest, to innovate, to lead, to create value where none existed before. Such determination, such striving to excel requires leaders — not just controllers, market analysts and portfolio. In our preoccupation with the braking systems and exterior trim (for example, return on investment), we have neglected the drive trains of our corporations."

Although enlightened leadership is surely required to create value, reduced dependence on analyzing investment returns is not the answer either. Measurement methodologies are not the problem; the way many companies use them needs to be reexamined.

Consider the way many companies justify CIM (and other DP) investments. The corporate controller prepares and distributes instructions and forms for evaluating capital expenditures as part of the capital budgeting and authorization system. For expenditures that involve business expansions or cost reductions, the instructions and forms typically call for the following:

- Forecasting differential cash outflows — for example, for a 10-year period or the life of the investment. Outflows include the initial investment, training and start-up expenses; operating costs; changes in working capital; and income taxes paid.
- Forecasting differential cash inflows for the same period. Inflows include revenues, recovery of working capital and a residual value in the last year of the forecast.
- Subtracting the cash outflows from the inflows to calculate a net cash flow by year.
- Discounting the net cash flows by a cost of capital to determine a net present value or calculating an internal rate of return (the discount rate where net value of inflows exactly equals outflows). Figure 1 (above) shows a format used for this purpose.

	Year			
	0	1	2	n
Outflows (Investment)				
Capital expenditure				
Expense items net of income taxes				
Working capital required	____	____	____	
Total outflows	____	____	____	
Inflows				
Revenues				
Costs and expenses excluding depreciation		____	____	____
Cash flow before taxes and depreciation				
Income taxes paid — net		____	____	____
Cash flow after taxes paid				
Residual value				
Recovery of working capital		____	____	____
Total inflows		____	____	____
Net cash flow	____	____	____	____
Effect on profitability computation				
Cash flow before taxes and depreciation				
Book depreciation	____	____	____	____
Profit before income taxes				
Income tax provision	____	____	____	____
Profit after income taxes	____	____	____	____
Taxable profit computation				
Funds before taxes and depreciation				
Tax depreciation		____	____	____
Taxable profit				
Measurements				
Internal rate of return	____ %			
Net present value	____ @	____ % Discount rate		

Figure 1. Capital Expenditure Budgeting Process

Although this methodology is conceptually correct, in practice it is commonly misapplied in several ways. It is unfortunate that this misapplication provides an uneconomical bias in favor of short-term projects at the expense of investments, such as CIM, that offer long-term strategic benefits. Five common pitfalls are:

- Evaluating CIM investments as stand-alone, cost reduction-oriented, capital expenditure proposals rather than as business-building strategic investments.
- Overlooking indirect cost reductions.
- Using excessive discount rates.
- Underestimating the residual values of CIM equipment.
- Relying on a single conclusion when a range of likely outcomes would be more appropriate.

The CIM investment decision is usually a strategic investment that a company makes to gain a competitive advantage, and it should therefore be evaluated in its entirety. The company should forecast and discount all the differential cash outflows and inflows associated with the strategy, not just the cash flows associated with the cost-saving component of the investment.

Differential cash flows are elements of cash inflow or outflow that are expected to differ if one course of action is adopted rather than another. Such cash flows may be estimated by adding up cost savings and marginal profit contributions before noncash charges (such as depreciation) or subtracting base case forecasts from forecasts that reflect an investment in CIM. The base case forecasts should reflect various competitive scenarios (for example, "the competition does not install CIM" or "the competition installs CIM"). The CIM installation forecasts should also reflect alternate investment and operating scenarios.

The base case is not zero. There is no such thing as a no-change alternative. If a company does not invest in CIM but its competitors do, the firm will lose competitive position. No change often translates into a decline and an eventual abandonment of a business. Decline and abandonment, therefore, may be the scenario that should be forecast as the base case for purposes of estimating the differential cash outflows and inflows for the CIM investment alternative.

Although direct cost savings are often relatively easy to identify, some companies overlook the impact CIM installations have on indirect costs. For example, CIM may require less supervision because fewer people are required. Fewer people reduce payroll and human resources department costs. Direct and indirect payroll cost reductions also translate into reduced payroll tax, pension fund obligations and other employee benefit costs. Reduced space requirements mean lower heat, light, janitorial, maintenance and other building occupancy costs. Improved quality results in reduced inspection, material handling, rework, scrap, yield and sales adjustment costs. Lower inventories result in lower inventory carrying costs. Such indirect cost reductions often exceed the direct cost savings associated with the installation of CIM systems.

Forecasts of net cash flows are usually discounted by a rate that reflects the perceived time cost of the capital (money) invested in a project. This discount rate is intended to reflect a company's capital cost based on the financial characteristics of the business. The National Association of Accountants defined the cost of capital in their publication, "Statement on Management Accounting: Cost of Capital" [Nov. 1, 1984]. According to that definition, the cost of capital is "a composite of the cost of various sources of funds comprising a firm's capital structure. It is the minimum rate of return that must be earned on new investments that will not dilute the interests of the shareholder." In practice, the cost of capital is supposed to be the weighted cost of debt and equity to be employed over the time horizon of the prospective investment (see Figure 2 below).

		After Tax Rate (Percentage)	Mix Debt/Equity (Factor)	Weighted Cost (Percentage)
Debt (54% x 12.8%)		6.9	.27	1.9
Equity (using Capital Asset Pricing Model)				
Equity Risk Premium (Assume)	6.0%			
Company Risk Adjustment (Beta Value Line)	.80			
Company Risk Premium	4.8%			
Treasury Bond Rate	11.0%			
		15.8	.73	11.5
			1.00	13.4%

Figure 2. Example of Cost of Capital Calculation

The cost of capital is not the same as a hurdle rate, which is simply a benchmark that some companies use to screen prospective capital expenditures. If the likely internal rate of return of a project exceeds the hurdle rate, the project presumably merits further consideration.

For at least three reasons, many companies discount their net cash flow by rates that exceed their actual cost of capital. Those reasons are the following:

- Because of the federal budget deficit, the current cost of debt and equity capital may be abnormally high and may not reflect future capital costs. Future costs of capital over the time horizon of the investment are the numbers that are most relevant for the investment decision.
- In a quest for financial conservatism, many companies underutilize long-term debt. A high proportion of equity tends to increase a company's cost of capital and the discount rate that is applied; a high proportion of debt tends to lower this rate.
- Also in a quest for conservatism, controllers tend to round up their calculations of their company's cost of capital. Thus, a calculation of 13.4% (shown in Figure 2) becomes 15% rather than 13%.

High discount rates favor projects that pay off in the short term rather than projects that, like CIM, offer long-term strategic benefits because of the effect of compounding.

Management may underestimate the residual values of prospective CIM investments, for example, by assuming that machinery and equipment will have a useful life of, say, 10 years and will be worth a scrap value at the end of that period. This is hardly the case. Not only may CIM investments (like commercial airplanes) have economic lives that will substantially exceed their book lives, but their residual value at the end of the tenth year will reflect the impact of inflation during those 10 years. Even assuming 4% per year inflation, today's residual value of $1 is equal to $1.57 in 10 years. This figure increases to $1.80 if a 6% annual inflation assumption is used. The problem is that while companies usually impound inflation in the discount rate they use, they often ignore it when they estimate residual values.

Financial managers often seek a single number forecast rather than an estimate of a high, low and most-likely outcome of alternative competitive and economic scenarios and discount rates. The forms are designed for one set of numbers so that each proposal can be compared with others. In reality, economic justifications are based on estimations subject to error in both directions. Thus, forecasts for CIM investments should reflect various scenarios and assumptions. Alternative assumptions, for example, should include a reasonable range of forecasts of the timing and amount of cash flows, residual values and discount rates. The array of computer-generated answers should be assessed using good, old-fashioned business judgment. Analysis should be used as a tool to assist economically sound decision making rather than relegated to the realm of braking systems.

If data is estimated objectively and biases favoring short-term payouts are eliminated, internal rate of return and net cash flow techniques can well serve corporate executives in justifying investments in computer-aided manufacturing systems.

* * *

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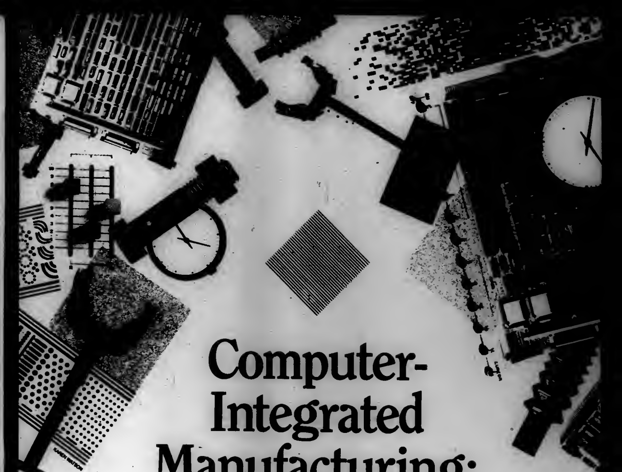
KAREN WATSON

Computer-Integrated Manufacturing: The Key Word Is *Integrated*

By Stan Kolodziej

The computer industry has always found manufacturing a tough nut to crack. The separate pockets of operations in manufacturing companies have resisted integration by computers. On the factory floor, for example, automated test equipment, programmable logic controllers and numerical control equipment, isolated from corporate management, have worked within their own closed-loop environment of specialized data and instructions. Beyond the shop floor, supervisory material scheduling and control also worked within its own requirements and cluster of work cells.

In the early 1970s, however, the first steps toward integration of the various components occurred. The advent of minicomputers allowed data processing to be dispersed at a lower cost among various corporate departments. Operating systems were more powerful, and programming was becoming easier for in-house personnel. On-line, real-time report writers provided quick distribution of materials handling, inventory and other data without the traditional time lag and channeling through MIS.

Also in development was the concept of materials requirements planning (MRP), an attempt by manufacturers to utilize the newly available corporate processing power to integrate applications such as billing, work in process, inventory, cost accounting, purchasing and other direct manufacturing procedures.

The emphasis was on integration. This emphasis on data integration, however, has occurred more often in theory than in practice. One major obstacle has been built-in resistance by various departments within manufacturing, which were driven by fear of change and reluctance to relinquish control.

Faced with the daunting complexity of the manufacturing market, turnkey systems houses had little choice but to produce specialized vertical market products that worked in relative isolation from systems in other departments. Aggravating the situation were the number of proprietary operating systems and software produced; interfacing with other vendor systems became impossible without extensive and expensive reprogramming.

Rapid growth occurred in yet another relatively independent and very important area of manufacturing: computer-aided design and computer-aided manufacturing (CAD/CAM). CAD/CAM has also attracted its own set of systems vendors which, until recently, provided application-specific products that remained all but isolated from other DP operations within manufacturing. With the recent economic downturn and increased competition from foreign manufacturers, however, U.S. industry has again been taking a long hard look at how computers and the linking of manufacturing operations can help increase profit and efficiency. A primary impetus has come from within the manufacturing industry itself.

Manufacturing resource planning (MRP II) goes a few steps beyond its predecessor, material requirements planning. MRP II is a planning and operating system that includes all manufacturing functions — material, capacity, finance, engineering, sales, distribution and marketing. MRP II is meant to be a generic set of operational rules applied to all manufacturing companies, regardless of size and product. Its basic premise is integration: its modus operandi is computers.

A working MRP II system is in place at the Pratt & Whitney Aircraft Co. in East Hartford, Conn. Ted Brindamour, Pratt & Whitney's manager of office automation, described the company's MIS data base as "very elaborate," and said the entire shop floor control systems of several regional plants provide data to it.

"Numerical control machines and logical controllers on the shop floors are online to the IBM mainframes in MIS at the East Hartford head office," Brindamour explained. "Data from the shop floors is used to produce work schedules, parts forecasting, machine time scheduling and identifying manufacturing bottlenecks for engine parts.

"Every two weeks we produce a new schedule, listing what kinds of engines we're going to ship, what kinds of spare parts, and then the system creates a new schedule for the shop floor to build to. What we're working on now is using the raw and finished material tracking to interface more with the financial group to do 'what if' scenarios and strategic planning."

Though this installation uses a relatively advanced MRP II system, it is only the first step in what the manufacturing industry has designated as computer-integrated manufacturing (CIM), deemed the ultimate evolution of computerized manufacturing. CIM has come to mean the implementation of a fully integrated data base that flows through the entire manufacturing process from process control to finance, with all intermediate steps — such as production control, scheduling, inventory, cost accounting and engineering — driven from the same data base.

Only In Hollywood

The word robot conjures up images of science fiction anthropomorphic androids wreaking vengeful havoc on its human creators or dutifully carrying out mankind's salvation. Of the estimated 19,000 robots now toiling in U.S. industry, however, most look more like one-armed cuisinarts than humans. The intelligence of most robots consists of taking a few simple orders and performing tasks that would tax the patience of a child.

Today's robots are used on the assemblyline to spot weld, arc weld, spray paint, move material and perform minor assembly jobs. Robots can work in areas that are toxic and dangerous to humans; they do not take breaks, do not belong to unions, do not demand sick pay, rarely countermand an order and really don't care how the Celtics are doing. Management likes robots.

Robots are incredibly structured workers. They have to be. The average robot is not a jack-of-all-trades. In fact, the average robot performs only a single function — but does it very well. Robots represent specialized labor to the nth degree. The curious fact that robots work in clusters, or cells, has nothing to do with their being gregarious. They are merely being cost effective. While one robot is doing a spot weld on one side of an automobile chassis, another can do the same on the other side. When they are finished, the chassis will continue down the conveyor belt and meet other welding robots whose areas of expertise might be doors. After these come the painting robots, and then the finishing robots. True division of labor, but hardly renaissance machines.

Times are changing. The buzzword in manufacturing is *system*. Customers want robot systems, with system applications, not just single machines. They want robots to be integrated, not segregated. They want robots to be holistic, not individualistic, to work in kind with other processing machinery, with support systems, with inventory control — to become part of the new team flexible manufacturing.

Robot makers have heeded the word. Systems they want, systems they'll get. Sometime in the future. Right now the robot industry is busy reaping what it has sown. Multiple vendors with multiple protocols, control systems and programming languages. No SNA-like standard exists in the robot industry. The closest is General Motors Corp. Manufacturing Automation Protocol (MAP), but it will be several years before MAP is strong enough to force robot vendors to conform to its standard. Until then, integrating robots into flexible manufacturing systems will cost dearly.

All is not gloomy. Robots are beginning to see the light — literally. Vision-capable robots are better, smarter and more reliable, thanks to major advances in signal processing semiconductor technology. These robots promise to be the leading edge in manufacturing systems of the future.

As for those Hollywood robots shown balancing the company books, don't hold your breath.

Implementing CIM is a huge undertaking, one fraught as much with organizational considerations as with the actual availability of CIM technology. Digital Equipment Corp., for instance, advises its clients that the implementation of its Baseway integrated manufacturing system should be overseen by a controlling group within an organization and not on a departmental basis.

"MIS is a service organization which has a heavy influence and responsibility in supporting the computer systems that are supporting the manufacturing environment," Denney LaBarge, DEC's marketing manager of manufacturing, architecture and networks, explained. "However, though the actual implementation of CIM systems might not come from MIS but from the various departments themselves, the strategic implications of a truly integrated environment require a focus by something like an MIS group to make sure the integration can be handled in a flexible and expandable manner. The market is moving toward a high degree of compatibility in the multivendor environment, but you still need either MIS or some other technical resource to oversee and advise."

ASK Computer Systems, Inc., a Los Altos, Calif., turnkey systems house and producer of the manufacturing management (Manman) integrated manufacturing system, sees nothing wrong in individual departments taking control of CIM integration.

According to David Sohm, ASK's vice-president of marketing, "The impetus to install a system like Manman can come from one of three places. The manufacturing department is often a key mover because they know they need a better tool for scheduling and planning. The financial side is also interested because by integrating manufacturing with the financial area, you can get better control over the financial end. The third area is MIS, which may be responding to questions from both the manufacturing and the financial groups, then coming to us for answers. Departments can implement almost in a vacuum, unconcerned about what the next department is doing, since we've already taken care of that problem through built-in controls."

Of those few computer vendors now beginning to offer several pieces of the CIM puzzle, DEC is in an unusually good position, in large part because of the early dominance of its PDP-11 computer on U.S. factory floors. PDP-11s control individual work cells through programmable logic controllers; the PDP-11s, in turn, are further clustered into groups of work cells usually controlled by DEC VAX minicomputers.

DEC has used this base to further penetrate into the MRP and MIS functions of large manufacturing concerns. Recently, DEC has seen the time ripe for the introduction of Baseway, its series of software products that will serve as the core of a manufacturing environment and the means to link both DEC and other vendors' equipment. Baseway is a sophisticated communications highway leading from the factory floor to MRP and beyond. The product consists of three software components: the Shopfloor Gateway, a hardware and software communications device running on a PDP-11 system and acting as a translator between specific shop floor devices and a host computer; the Baseway Application Software Bus, which runs on the VAX/VMS operating system, communicates with control devices on the shop floor and provides a common means of sharing data throughout a factory; and the Programmable Device Support, a menu-driven application capable of downloading and uploading, reading and writing, comparing, documenting and maintaining a library of ladder logic programs.

"While MIS can use the shop floor data made available through Baseway," LaBarge explained, "most of the companies using Baseway are employing it in a decision support mode for the management functions essential to keeping the manufacturing plant operating. This includes material management, quality control, maintenance, supervision and superintending and keeping track of production statistics to reconcile against the production schedule. Reports can be created showing the current production status of an entire plant, by departments, workstations or individual machines."

DEC also seems committed to the needs of users in a multivendor manufacturing environment. Gateways from Decnet networks to IBM Systems Network Architecture (SNA) environments provide a good avenue for DEC and its large manufacturing customer base to further extend into the IBM-controlled MIS departments, a logical step if DEC is intent on influencing future manufacturing MIS purchasing decisions.

LaBarge added that DEC is also intent on producing products that will be compatible with both the International Standards Organization's Open Systems Interconnect and the General Motors Corp. Manufacturing Automation Protocol (MAP) architectures, both gaining more popularity and support in manufacturing.

Baseway represents the flagship CIM product from DEC, and more will be forthcoming from Cimlab, the company's newly opened CIM laboratory located in Shrewsbury, Mass. Cimlab will be DEC's primary facility for developing and testing its CIM products.

Computervision of Bedford, Mass., one of the pioneers in CAD/CAM application systems, has attempted to integrate MRP II and CAD/CAM through Factoryvision, a microcomputer-based factory floor management system. The heart of the system is a 32-bit Computervision CDS 3901 CPU supporting up to 16 view-only terminals. The Factoryvision data base consists of text and graphics such as engineering and detailed drawings, process plans, assembly instructions and numerical control data. Product information created and stored on Computervision CAD/CAM systems is distributed by Factoryvision throughout the various levels of factory management and operations, enabling designers, engineers and administration to maintain drawings and project data. It will also provide floor managers and production workers on the factory floor with up-to-date graphics and instructions.

Factoryvision draws on Computervision's extensive CAD expertise to tie together the CAM, or manufacturing element, with graphics, a union that until recently has been more one of words than of substance. "The general decline in computing costs has made it economical to distribute CAD/CAM data directly, instead of relying on hard copy carried by hand," John Langley, Computervision's product manager, said.

Factoryvision is aimed to achieve graphics data distribution through three modules. Planning and Administrative is used by engineers and designers for the viewing and maintenance of drawings and plans. Production System carries production data such as process plans, tool lists and work load and distribution data directly to the factory floor. Machine Tool Management enables numerical control data to be sent through the Factoryvision network to a shop floor machine tool, coordinate measuring machine or robot — without the use of tape.

"We're not creating graphics or generating requirements or detailed scheduling," Langley explained. "Factoryvision acts as a conduit to channel process information down from MRP and CAD/CAM to the factory floor. A typical application would consist of a demand created in MRP, followed by a suppply order sent to the shop in the form of a schedule. Once the order is completed, a feedback in the form of a transaction goes back to an MRP mailbox so that files can be updated to relieve demand. We're really the middleman between the business systems and the factory."

ASK Computer Systems has specialised in providing turnkey systems for MRP for almost a decade. Starting with an inventory control package, ASK has gradually extended its offerings to try to keep pace with the expanding role of MRP. "From the inventory core," Sohm explained, "we added a master scheduling module, a capacity planning module and materials requirements planning. That set was basically what people in the past called materials requirements planning. When you add order entry, accounts receivable and payable and general ledger, you have MRP II."

ASK's Manman MRP II system is structured around 16 modules, Sohm said, and runs on either Hewlett-Packard Co. 3000 series or DEC VAX series computers. Data flows in two directions. From the factory floor, process data can be keyed into terminals and fed into the central computer, which can reside in MIS or elsewhere (Sohm stressed the location was relatively unimportant). Factory floor information tracking material movement and processing is fed immediately by the central computer into general ledger files, booking those material usage costs to appropriate general ledger accounts. As this data is processed, production schedules are updated, enabling management to recalculate production schedules on a regular basis.

ASK and other CIM systems suppliers are learning that being profitable in CIM means coming to terms with a manufacturing world dominated by DEC and IBM. As MRP II becomes more of an MIS-influenced and MIS-driven function, systems vendors are providing gateway facilities to tie into IBM mainframes and DEC minis.

High-profile CAD/CAM vendor Apollo Computer Corp. of Chelmsford, Mass., for example, has made sure its new Domain networking software can tie users into IBM computers through 2780 and 3780-terminal emulation and DEC computers through an Ethernet gateway. A gateway to IBM's SNA network is scheduled soon. Bill Kaiser, Apollo's manager of CAD/CAE/CIM market development, said, "IBM will not be able to cover all the bases in CIM for some time. However, as CIM becomes more of a corporate concern, with MIS a major player, any vendor that can't relate its products to IBM MIS data bases is going to be isolated."

Analysts generally agree that if any company has the resources to market a complete CIM system in the near future, it is IBM. Though cool and reticent about its intentions in the CIM market, the computer giant has been quietly putting the pieces together for what seems to be a planned assault on a CIM market that should reach $73 billion in the U.S. by 1989, according to International Resource Development, Inc., a Norwalk, Conn., research outfit.

In the CAD/CAM area, IBM's extensive offering of software packages includes Cadam, for drafting; Catia, for three-dimensional mechanical design; Caeds, for linear analysis; and CBDS, for circuit board design. Late in 1984, IBM also lowered prices on its models 4331 and 4361, the same superminis that drive IBM's CAD/CAM systems and are used extensively throughout manufacturing MIS departments. At the low end, IBM will be introducing a Cadam version for its Personal Computer and will also announce a ruggedized version of its Personal Computer for shop floor use. At the high end of the CAD/CAM market, IBM is aggressively pursuing penetration through value-added resellers to regain an engineering segment they had all but lost over the past two decades. It is conceivable that by the end of this decade, IBM will be a major force on the shop floor, in the design and engineering departments and in corporate industrial DP, three areas that comprise the main building blocks of CIM.

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Kolodziej is a senior writer at Computerworld Focus.

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Automation Heats Up At Lukens Steel

By Lee White

Lukens Steel Co. in Coatesville, Pa., has a history of making history. Brandywine Iron Works and Nail Factory became the first U.S. iron company headed by a woman when, in 1825, Rebecca Lukens took over the mill her father founded. In spite of lawsuits instituted by her family, she ran the company until 1840 and lived to see it renamed in her honor.

More than a century later, Lukens Steel made history once more. In 1960, IBM and Lukens joined forces to computerize the guiding of electric furnaces by means of an IBM 1800. Twenty-five years of computerization and 175 years of steelmaking later, Lukens hit the Fortune 500 — at the 500th place. Those 175 years were not all good years, however. Lukens' success story could be compressed into the last five of those years and can be attributed to state-of-the-art computerization and state-of-the-mind people. That success came in spite of the fact that steel production at Lukens fell from 734,000 tons to 483,000 tons between 1980 and 1984, profits declined, the number of salaried personnel was halved and the ranks of steel workers decreased by 35%. In 1983 Lukens lost $14 million.

Lukens wasn't the only organization in trouble. The steel industry was suffering across the board, partially because the economy was soft and partially because an influx of less expensive foreign steel was under way. It was during this period that management decided some drastic changes had to take place in the way business was conducted.

On the decision-making body guiding these changes was Al Eastburn, vice-president of manufacturing services and planning. Eastburn reports directly to W.R. Wilson, president and chief executive officer of Lukens, Inc. (Lukens Steel Co. is a unit of Lukens, Inc.) and reporting to Eastburn is Lukens Steel's entire DP department, which is divided into management information systems and process control. Eastburn knew that the key to competitive steel making was automation of the process and timely dissemination of information and product to Lukens' customers. For about three years, these two projects have been evolving. They are expensive, in terms both of hardware/software and of staffing requirements, but Eastburn convinced top management the money had to be spent.

Providing for efficiency in a steel mill was no easy task. After an order has been taken, mill instructions are generated by computer and can be 30 pages in length. These instructions are written by the IBM 3083 and are based on metallurgical, customer or processing requirements. If there is no plate in inventory, the order and others of the same chemistry or size are accumulated until the total approaches 160 tons. At this point, the department prepares a furnace, a process also known as "setting a heat." From this point on, the progress of the heat is tracked by local process control computers until shipment occurs.

Two systems resulted from the years of work: Materials Tracking and Expediting (Matrex) and Status On Line (Statline). Prior to Matrex and Statline, according to Mark Kamon, manager of production control and rolling, 200 people worked in production control. These people tracked 650 to 700 orders per month and coordinated 22,000 pieces of steel (in various stages of completion) through 900 acres and 50 different buildings and operation locations. The primary task of these workers was to communicate order status to salespeople and customers. A customer who called to inquire about an order got his information two days later, at which point it was two or three days old and often incorrect.

"We had this mass of people all over the plant who kept those records. They were late, transposition errors were incredible, you had handwriting off sometimes illegibly handwritten documents [that might be] the fifth copy. It was very inefficient, very unprofessional and error-prone from beginning to end. Ergo, Matrex and Statline," Kamon said.

Matrex is the system into which plant personnel key information as the raw material wends its way through processing. When enough raw material has been accumulated, it is melted, poured, cooled, heated again, rolled, laid out, cut, inspected, loaded and shipped. At each point in the process, the status is plugged into the computer. Statline is fed by the Matrex system in an on-line, real-time environment. When a customer or salesperson calls, the sales support person keys in the mill order and item number and can immediately tell the caller the status of the order.

One of the more difficult processes that culminated in Matrex and Statline began in July 1984. Martha Dixon, project manager, and Tom McFadden, lead information services analyst, were charged with automating the tracking system. "We were concerned because we were designing a system for 300 people — union people — working in a manufacturing environment. These people had no concept of computers or keyboards," McFadden said. Their motivation level was also suspect: They were asked to take time from their work to input information into a computer, but they were paid no more for the extra task. Dixon knew the solution would have to be creative.

The answer came in the form of 12 laid-off and retired Lukens plant workers who were rehired to train factory personnel. In an almost circus-like atmosphere "simultaneous activities were going on, major activities. Tom was designing [the system], the programmers were programming, the user was defining the needs. We were also reconfiguring an IBM 4381 and installing an IBM 3083. There were 55 CRTs and printers [to be installed] for this project alone," Dixon explained.

And it wasn't just the systems staff that contributed to the endeavor. Telecommunications was involved with cabling, and the cubicles that housed the computer terminals had to be built and installed. "It was a very dynamic, fluid process. The training aspect had to go on because there were about five or six major transactions that occurred; all the processes we go through with plate [steel] — all had to be designed," Dixon said. The due date for completion of all hardware and software installation, designing, testing and training for the first two buildings and personnel was Sept. 17, 1984. The staff made that deadline, and by the end of October the entire project was completed.

According to Dixon, McFadden and Kamon, the key factors in the successful completion of the implementation were the resourcefulness and motivation of the trainers and the receptive attitudes of the hourly and salaried factory workers. Dixon had high praise for the trainers. "Everybody had a great deal of respect for them. They were brought in for a very temporary assignment, and they put their hearts and souls into it. They trained the people, they learned, they tested for us and they worked odd hours. The retirees — some of them had been with the company for 20 and 30 years — knew the operations out in the mill, they knew the people and there was acceptance [of them] by the union workers."

Mill workers got equally high marks. "The hourly union people have no constraints on them. [Data entry isn't] tied to their payroll. It's strictly an honor system, and we're getting in the neighborhood of 98% of the data input into the system. I still to this day cannot believe we're getting 98%," McFadden enthused. Kamon echoed McFadden's sentiments. "They're inputting 20 characters at a pop. We want it timely, and we want it right. We audit [input] and it's 99%-plus accurate the first time."

These efforts resulted in an extremely favorable bottom line. The customer satisfaction rate, determined by quality of final product and on-time shipping, was approximately 30% in the second half of 1984. After implementation of Matrex and Statline, the customer satisfaction rate increased to 90% in the first quarter of 1985. Ron Jones, manager of customer service, sent surveys to Lukens' customers recently to see what effect Matrex and Statline have had. All surveys were returned with favorable reports.

Jones cited one example of the turnaround Lukens experienced. "There is a bridge fabricator in the South. This time last year he refused to give us another order. We went to him after we got the system in place and were able to sell him on the fact that we had changed. He gave us another chance, and we have an almost perfect record with him."

But the computerization of the tracking and expediting portions of Lukens Steel is only half the story. In the early '80s, process control (which had been phased out in the '60s) was reactivated when Eastburn hired Sharon Muscedere as supervisor of process control. Muscedere, an electrical engineer, had never worked in the steel industry, but the challenges sold her on the job. "There were a hundred different projects I could see right off the bat. The other steel companies were really ahead of us when I first got here, but we're catching up fast. Right now we've got a project priority list that can go on for the next 10 years."

Key factors in the successful implementation were the resourcefulness and motivation of the trainers and the receptive attitudes of hourly and salaried factory workers.

The first step for Muscedere's process control group was a migration from the centralized 1800 to three levels of distributed control through Digital Equipment Corp. computers. Traditionally an IBM shop, Lukens made a conscious decision to go with DEC, according to Russ Melton, Eastburn's assistant. "[IBM] abandoned the process control side and all the engineers came through college learning about DEC, so that was the machine of choice. IBM would really like to get back into this business, but they've got a long, hard pull ahead of them," he commented.

After the hardware decision was made, Muscedere had to find a way to collect sensor information. Lukens chose Gould, Inc. Modicon programmable controllers for their heavy-duty construction and ability to function in a dirty, non-temperature-controlled environment. Another important reason was that the controllers require no programming language. "They use ladder logic very similar to the schematics electricians are familiar with," Muscedere said. "After we install them, the maintenance department is able to support them for us."

Another problem was data communication. Because heavy drives and machinery cause electrical interference in the plant, data communication over twisted pairs was not good enough. Muscedere and her staff decided to install fiber-optic communication lines and statistical multiplexers to put intelligence at both ends of the line.

But the biggest job was converting from the 1800 to DEC PDP-11/44s and finally to a DEC VAX cluster. "We found that the scope grew with the project. We wanted to have growth built in," Muscedere explained. At present there are three VAX-11/750s: one for the live system, one as a backup/test system and one for development. The company expects to add another live system in the near future.

The process control group had given much thought to the problem of growth. "One thing certain in process control is that sooner or later you're going to upgrade to larger computers, so there is a definite need for transportability of software," Muscedere said.

To ease the growing pains, the company custom designed a virtual operating system (VOS) for all the software. Lukens has already realized tremendous benefit from the effort; in the migration from PDP-11s to VAX-11/750s, 95% of the software did not have to be rewritten.

The general environment of the steel mill couldn't seem less well suited to computerization; the mills are dirty, noisy, old and hot. Yet an astonishing amount of automation is taking place. Describing the inside of a steel mill is difficult, but the phrase "sensory overload" is appropriate. The furnace itself has a 22-foot inside diameter. The buckets carrying the scrap steel that is dumped into the furnace weigh 70,000 pounds each when empty; the scrap charge adds another 130,000 pounds to the weight. Each heat uses at least three buckets of scrap. The roof of the furnace lifts and rotates 61 degrees to allow the bucket of scrap to be poured into the furnace, and the roof itself weighs approximately 150,000 pounds. The furnace's total weight with three buckets of scrap is 1,300,000 pounds.

The electricity consumed for a furnace's heat is so high that Lukens pays the highest electric rates in Pennsylvania. To minimize that expense, most heats take place in off-peak usage hours. The heat attained in each furnace approaches 3,000 degrees Fahrenheit. One furnace uses 800 kilowatt hours of electricity per minute; the average house uses 500 kilowatt hours per month. Strolling through the melt shop when it's 90 degrees Fahrenheit outdoors and fire is belching from the furnaces is enough to convince those who believe in hell to try and lead a better life. When one then realizes that a computer is sensing, moving, monitoring, recording and reporting all activities from the selection of the scrap to the melting of the steel, the enormity of the task is underscored.

Much of the operator's job is done from the pulpit, a glass-enclosed area a few yards away suspended about one story over the furnaces. The operator uses CRTs and buttons to monitor the scrap, the weight of the buckets and the heat chemistry. When all the numbers are correct, the furnace is turned on. Dave Kramer, lead systems engineer, explained that the entire system, called Operator Guidance and Control, exists primarily to supply just the amount of energy necessary. A secondary purpose is to collect data for an historical file, which includes targeted chemistries and unusual events of the heat. This information, combined with data from computers in the chemistry laboratory, is put into a data base that is transmitted to Mathematica Products Group, Inc.'s Ramis on the IBM 3083.

Kramer is heading up another automation project at the West Side building. At present, two furnaces heat treat high-carbon plate steel. Prior to the project's first phase, temperature was monitored by 35-year-old controls. Kramer and his group brought in a Leeds and Northrup Co. Max 1 distributed control non-language-based system, added various other digital displays and improved temperature control from plus or minus 30 degrees to plus or minus 5 degrees.

The second phase, which is in progress now, is to add a DEC PDP-11/73, a microcomputer and a Gould Modicon 584. These additions will control temperature and aid in tracking the product. Kramer's group is presently designing a touch-sensitive screen to allow operators to select information. This will produce a chronological report that can be used by the metallurgical groups to evaluate and improve the process. The third phase, which Kramer hesitated to call the last, will "beef up" the supervisory computer and automatically link the monitored information. In addition, "there will be functions to improve combustion control for energy conservation. This will be communicated to the [IBM 3083] so we can get historical production information into Ramis-like files to statistically evaluate necessary improvements."

That Lukens is on its way to state-of-the-art from a computer standpoint is obvious. But Wheeling-Pittsburgh Steel Corp. spent $700 million to modernize its steel-making operations, only to be forced into filing Chapter 11 bankruptcy in April 1984.

What sets Lukens apart is the respect its managers show for the workers and the resulting willingness of the workers to do their part to make the company function better. Kramer, who works quite closely with many of the factory personnel, said the operators have received the systems very well. McFadden added that the workers were very aware that their futures hung in the balance. "We had gone through two years of losing money. They all recognized that this was an effort that was going to make the company more profitable," McFadden said. Muscedere, whose background had included clean-tech E.I. DuPont de Nemours & Co., expressed surprise at the workers' easy acceptance of process control automation. "The operators, the union people, desperately want computer assistance. I find that attitude refreshing — really different from other places I've worked."

Rebecca Lukens might have a hard time understanding the concept of automation, but she'd no doubt be very proud of the company that bears her name.

* * *

White is senior writer at Computerworld Focus.

FOCUS ON:
TECHNOLOGY

Decision Support Systems— New Tool For Manufacturing

By Allan F. Ayers

The number of manufacturing control systems (MCS) has grown enormously in the past decade. These systems, commonly known as MRP systems, evolved from the materials requirements planning process. More than 140 of these systems are currently on the market. Some are truly full MCS; others provide only parts of the MCS. Many operate on more than one type of hardware. Some are strong in planning; others in shop floor control.

All of these systems, however, have one thing in common: They are principally operational systems — designed to process the following operational activities:

- Receiving daily or weekly input transactions such as orders, shipments, receipts and detail forecasts.
- Generating detail-level outputs such as shipping documents, production orders and requirements lists.
- Providing detail inquiries such as bills of material structures, open orders and available inventory.
- Day-by-day systems control.

What most management control systems lack is the summary-level management information managers need to plan and manage the overall performance of the business. There is a valid reason for this omission: The realm of management information cannot readily be packaged. Management styles differ; therefore presentation and analysis will vary. The actual measurement and reporting requirements are different and depend on the nature of the business and the analysis required at the moment. Management information is also less structured and cannot be routinely scheduled. This is where decision support systems (DSS) become useful.

DSS Environment: DSS are used to solve information problems in a particular environment. That environment is created through the following conditions:

- The problem is too complex to be solved by hand. Complexity may be caused by the volume of numbers, the difficulty of the analysis or both.
- The problem continues to change with the high degree of uncertainty and is probably event driven. There are frequent changes in variables that may be updated either on a time schedule or in response to some level of control feedback. (For example, decisions about inventory stocking levels may change as interest rates drop.)
- The inputs to the problem cause frequent rerunning of the process to evaluate the new results.
- The answers are needed in a short time relative to the nature of the analysis.
- Intermediate results may be used to specify the direction of the rest of the processing; therefore the problem calls for an interactive person/computer relationship.

Data Acquisition: A DSS must have the flexibility to draw data from several sources. The principal source would normally be existing computerised data bases. These bases may be in any of several forms ranging from simple sequential data files to elaborate data base structures. Because a DSS would presumably operate on a copy of the data rather than on the data base itself (to protect data integrity), this variability in structure need not be a complex problem. It may require interface programs that draw data from the data base and load it into file structures suitable for the DSS. A major problem in dealing with corporate data is the size of the data base. With very large hierarchical data bases, a thorough analysis of the data to be provided for the DSS and the frequency of revision are essential.

A second source of data would be manual inputs from the user of the system. A DSS should therefore have input loading and data file management capabilities. Many available DSS software products have complete CRT screen development and data entry editing capabilities. A company doing an analysis of requirements for selecting a particular product should pay close attention to its needs in this area.

A last source — public data bases — is becoming increasingly more significant and is now available via computerized communications. Public data bases are usually retrievable through personal computers or data terminals. To be used in conjunction with data from company resources, this data clearly has to remain in computer-readable format and be communicated to the hardware system running the DSS software. Other methods of obtaining this data include periodic computer tapes and, for larger client companies, direct computer communication.

Data Processing: A DSS should be able to perform several types of processing on the data in the system. First, the data may have to be aggregated, merged or otherwise manipulated to put it into an appropriate level of detail and configuration for analysis. This would be considered a processing step. Second, the preprocessed data will be analyzed. This may include statistical analysis (such as linear regression), groupings or percentages of totals or matrix manipulation using an electronic worksheet approach. Third, all these manipulations might call for "what if" capabilities or other simulations to test results and the sensitivity of those results to changes in the data.

Data Presentation: A DSS must be able to present the results of analyses. This presentation may take the shape of either a line by line display on a video display terminal or a formal report with graphics incorporated.

Computer resources that the DSS will use has still not been addressed because the DSS can be implemented either on personal computers (linked to the corporate computer) or through computer software tools directly on the corporate computer. The technical aspects will differ, but the concepts will remain the same. Some examples of software available to support a DSS are shown in Figure 1. This list is not complete, and the breadth of capabilities varies significantly from one tool to the next. (Special-purpose tools that would add to a DSS have not been included.)

DSS in Manufacturing: The number of ways a DSS could be applied in manufacturing are limited only by the manufacturing manager's imagination. A standard MCS consists of 10 or 11 modules covering the systems shown in Figure 2, Page 38.

These systems are all oriented around transaction input and day-by-day control. Depending on the specific MCS, individual modules may have some additional features; some may have capabilities for aggregate management-level information. The latter, if available, is most likely of a limited nature.

Four DSS processes relate directly to senior-level manufacturing needs. These four, which can have a major impact on the

Personal Computers

Symphony
Dbase II
Rbase
Dataflex
Oracle
PC/Focus
Nomad2

Minicomputers

Oracle
Info
Ingres
Natural
Relate/3000
Datatrieve
Queo-IV

Mainframes

Oracle
Focus
Nomad2
Natural
Ramis II
IDMS/R
Express
Manage

Figure 1. Software Tools

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quality of decisions made and on the bottom line of the income statement are production/sales/inventory (PSI) planning, management performance, quality management and manufacturing/distribution coordination.

Production/sales/inventory planning: The PSI process provides management with a methodology by which sales, finance, production and inventory relationships can be optimized. This relationship can be improved only through the realization that the planning process is implemented from the top down and that each successive level of achievement depends on the achievement of the preceding level. Business planning leads to production planning and performance, which in turn leads to sales (customer shipments), aggregate inventory levels and, ultimately, to master scheduling (that important document that drives our total manufacturing operation).

The objective of the PSI plan is to develop a course of action that maximizes market penetration under the constraints of production capacity and inventory investment. The PSI process is an integration of sales, manufacturing, logistics and financial data to produce a continuous 12-month master production plan at a product family level. The process begins with a sales forecast by month of the number of units required in each family for the next 12 months. Production plans are then calculated to meet sales requirements and desired finished goods inventory targets. The production plans are reviewed to assess the plant's ability to respond. Finance also reviews the dollar results of the forecast, inventory and production plans.

The PSI plan is at a family level suitable for senior management attention. This implies a maximum of about 10 to 15 families.

The PSI process is iterative. Each month, sales submits necessary changes to the existing forecast and projections for the 12-month planning horizon. Manufacturing reviews required changes in light of current assembly and procurement lead time constraints, capacity limitations, inventory position and the master schedule impact. Top management has the final right of review on the PSI plan. After top management has revised and approved the plan, changes and inputs to the master schedule are made.

The implementation of the PSI planning process requires several inputs:

- Sales forecast data is usually by product family and month for 12 months. The data should be expressed in terms of units where possible. This may be obtained through a computerized or manual forecasting system.
- Production planning data (which expresses current plans for the plants) is by product family and month. These units may or may not be in the same unit of measure as a sales forecast; if not, one or the other must be converted.
- Inventory target levels are expressed in turns, weeks of inventory or units on hand.
- Financial data converts all plans to dollars to determine the financial impact.

The processing concept is relatively simple: Beginning Inventory + Production — Sales = Ending Inventory.

In the real world, sales may be projected to exceed production capacity or to be far below capacity. In both cases, decisions that will call for compromises must be made. Inventory targets may be ideal, but the actual balance of inventory between various stocking points may prohibit reaching the targets. The system would process the equation, reflect the results and provide the ability to balance the system by revising the plans to the relative satisfaction of all key managers.

To process this type of an analysis, a spreadsheet system can be used if it has appropriate links to corporate data. The corporate data would provide, among other things, current actual results as well as current master production schedules (that aggregate into the total production plan) and possibly sales forecasts.

The operating environment for the PSI planning process should include the following steps:

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- The sales forecast would be provided either through aggregating individual item sales forecasts up to an appropriate product family level or by using product family group forecasts. The use of item forecasts would assume that the individual item forecast had already been reconciled with higher level group forecasts created independently to provide a satisfactory sales plan.
- Actual sales data as provided by customer order processing and sales history systems would be accumulated to the appropriate level.
- Inventory results would be generated based on the sales forecasts and desired targets to meet customer service objectives.
- Production needs would usually be projected based on meeting inventory targets at the product family level. Aggregate production needs may be developed by summarizing individual production requirements if item projections are used.
- Summary results would be reported comparing sales and inventories and production.
- Where problems occur, detail information must be available to be analyzed to revise the aggregate results. Subsequent adjustments must be made to detail-level data (forecasts, inventories or production plans) to reflect the revised plan. This adjustment is usually an update to the master production schedule.

Production management performance analysis: The management performance process should be looking at appropriate summary-level objectives for performance and reporting actual results against those targets.

Quality management recently gained a lot of attention as a means of improving a company's competitive position. Unfortunately, quality management is a little bit of mom and apple pie. In the real world, the range of success with measuring and managing quality has been wide. Beyond the ability of tracking inspection results and measuring statistics for acceptance and rejection in materials, quality management frequently gets limited systems attention. There is a real relationship among quality, profitability and market share. In a study by the Strategic Planning Institute, the bottom line return on sales doubled with an improvement in quality, which justified a 9% increase in selling price.

Quantifying quality, especially perceived quality, is difficult. However, an index of product quality can be developed by measuring and evaluating key factors that make up quality. This index then becomes a relative measure that can be tracked and compared to predefined targets. Factors that make up quality might include level of rejects in key materials, level of intermediate assembly inspection rejects, level of final product inspection of rejects, warranty repairs, production problems and mean time between failures.

Perceived quality is more difficult to assess and will be determined through market analysis. If a measure of perceived quality can be obtained, comparing it with the quality index (based on objective data) can provide a measure of a product's present position. (See Figure 3.)

A DSS provides the tools with which current quality factors can be measured and potential improvements analyzed. In addition, more detailed information could be captured for analysis. The most important additional need is to understand causes for rejects at each inspection point; failures cannot be resolved unless causes are identified.

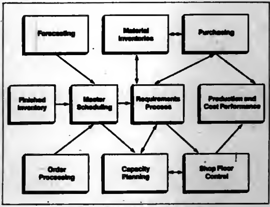

Figure 2. Manufacturing Control System

Another process in which DSS provides useful support is yield analysis of production output. Through statistical sampling, a process can be evaluated to determine average yield (or tolerance level) of a production process. In addition, statistical boundaries can be established to provide a specificed probability that subsequent production runs are within acceptable levels. Production runs that exceed limits are then examined to analyze reasons for their being out of the acceptable range.

The DSS would be used for both statistical analysis (using suitable statistical tools) and tracking (gathering and retaining actual production data). The DSS would also be able to simulate the implications of changing the process parameters either in the statistical analysis or for tracking the process.

Rework costs and controlling rework product might also be a part of the quality management DSS if this process is not included effectively through the MCS.

Although there is a substantial overlap in the functions performed by physical distribution and materials management entities in a company, the coordination of planning and action between manufacturing and distribution is often a large black hole. Because cost economies are available through developing a well coordinated distribution and manufacturing interface, this is a fourth key role for DSS. Developing the concepts of the distribution and manufacturing coordination system begins with identifing the points of interface and working backwards to identify the source systems affected. For example:

- Customer delivery dates may have to take into consideration the next replenishment of a distribution center, which may in turn be dependent on a production run. The replenishment may be on a routine cycle that coordinates outbound shipments with pickup of material from vendors. The order due date may also have a much more direct connection with manufacturing in some process industries or job shops where production is planned on a first-come, first-served basis or on a consistent production cycle.
- Production plans may be dependent on rebalancing inventories in a distribution center or on the inability to rebalance those inventories. More and more is being heard about distribution requirements planning (DRP) as a means of developing requirements for a plant. DRP, however, is only as good as the distribution center and plant information, particularly relating to forecasts and product availability. Production planners may need to be able to review distribution center needs in light of a plant service area.
- Customer service performance is a major factor in distribution performance. But service factors also affect inventory levels and quality management. Rarely are the most appropriate service measurement factors provided in an off-the-shelf order processing system because the parameters that are effective in the real world are closely related to the company and industry in which it functions. The DSS can be used to capture basic data from the order processing system. This information might include order date, original due date, actual ship dates, lines shipped complete on each shipment and partial shipment information. Added to that data might be other measures of service. The DSS would provide flexibility to analyze this data and improve the quality of customer service.
- Transportation planning calls for the ability to combine outbound shipments with inbound receipts. If those can be balanced, there may be justification for a contract or private fleet. If that fleet is already in existence, its cost-effective use requires knowledge of both planned receipts and planned shipments.

The DSS is the bridge that provides the capabilities to pull the source data from the various operating systems and to generate these analyses.

A decision support tool provides a mechanism for developing application systems that have a direct impact on the bottom line — reduced costs for inventory, production, freight and distribution — and improved sales through quality management and more responsive production planning.

The most effective use of a DSS in manufacturing occurs in conjunction with the already existing manufacturing and distribution control processes. A DSS should not replace routine system data collection and reporting that can be performed more efficiently through data processing production systems. A DSS will, however, contribute to the success of any system by providing a flexible set of tools for management analysis of the results.

The reason MCS took so long to evolve is that the computer power and resources were not available. Now they are — on-line processing, powerful systems to handle the complex MRP and capacity requirements processing, shop floor data collection equipment and, now, DSS to custom design management's needs.

■

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A quality index will enable a company to track the impact of their quality practices on the market perceptions of their products. As a correlation is developed, details behind the quality measurements can be analyzed to improve the production process in the future.

Steps to develop a quality index might include:

- Obtain from the manufacturing control system (or a statistically-based quality measurement system) the rejects for finished goods, assemblies and parts — either purchased or manufactured.
- For each type of rejects, develop frequency of occurrences, cost per occurrence and weighting factor that would put the various types of rejects into a reasonable balance. For example:

Type of Rejects	Number	Cost	Weight	Value
Finished Goods				
Assemblies				
Purchased Parts				
Manufactured Parts				
Raw Materials				
Internal Quality Index				xxxx

- Obtain and track field service repair information and add this information into the quality index, weighted as suitable.
- Conduct periodic customer surveys through a telemarketing organization to appraise perceived quality of the product in the marketplace. These surveys, conducted quarterly, could rank performance on a scale of 1 to 10 for repetitive types of products or on a better/same/worse than a year ago basis for products of a more durable nature.
- Plot internal quality index, field service index and customer survey for correlation over time.

Figure 3. How to Establish a Quality Index

FOCUS ON: TECHNOLOGY

Micro-Based CAD Systems – From Plain Vanilla To Thirty Flavors

By Stan Kolodziej

Until micro technology opened up the computer-aided design market to new groups of users, the only game in town was run by companies like Computervision Corp., IBM, McDonnell Douglas Automation Co. (McAuto) and Applicon, Inc. These vendors offered powerful, multiuser systems that allowed from two to four engineering and design workstations to be attached to a central minicomputer or mainframe. Although the systems were expensive — up to half a million dollars — the design features were excellent, offering 1,024 by 1,024 pixel screen resolution and dedicated CAD software with capabilities such as three-dimensional and multiple viewing, solids modeling, windowing and sharing graphics data bases with other designers.

High price tags, however, were not the only complaint users had about these large systems. A major problem was that several workstations competing for memory placed a drain on the central computer, and response times could become sluggish. CAD was meant to be transparent to designers and to augment their creativity by letting them work at the speed at which they thought rather than the much slower speed of traditional manual drafting. Sluggish response times therefore contradicted the intent of the system.

Another problem was finding time for designers on individual workstations in the multiuser systems. Per-seat prices of host-based systems remained high, availability of workstations limited and only the largest corporate users — traditionally those with revenues over $50 million — could cost-justify installing multiple CAD systems.

A new breed of CAD vendors arose to capture a share of the burgeoning CAD market and fill the demands of companies that could not afford the larger multiuser systems. These vendors began marketing relatively low-cost, single-user technical workstations that could offer many of the design capabilities of the large systems at a fraction of the cost. The new systems also satisfied a craving of large corporate users to further distribute CAD in-house while keeping costs down. As a result, these vendors began opening a market roughly 10 times larger than the traditional CAD market.

Instead of running data through a central processor, technical workstations took advantage of newly introduced 32-bit processors such as the popular Motorola Corp. 68000. The 32-bit processofs could handle the rigorous floating point computation and number crunching involved in producing high-resolution CAD drawings and still provide necessary fast throughput. Another advantage was the networking options that enabled these workstations to be linked for the exchange of data. CAD users found they could now have extensive CAD capability for less than $100,000.

A good example of such a system comes from one of the pioneers in technical workstations, Apollo Computer, Inc. of Chelmsford, Mass. Apollo's Domain system consists of individual 32-bit workstations linked by a local-area network. Workstations provide from 1M bytes to 4M bytes of main memory, 1,024 by 1,024 pixel resolution and extensive hard-disk storage. Domain bit-mapped, raster-scan displays use independent 1M bytes of random-access memory for color display. Applications for which Apollo has slated Domain include three-dimensional wireframe, solids modeling and finite element analysis for mechanical engineers; schematic capture and integrated circuit design for electrical engineers; and architectural and structural drawings for the architecture, engineering and construction (AEC) market. Domain packs the punch of a large CAD system into a series of microcomputers.

Many technical workstation vendors are gradually incorporating AT&T's Unix as the operating system for their products. In a market originally known for its array of proprietary operating systems, more vendors are porting Unix versions such as AT&T's System V standard and the Berkeley 4.2 version onto their machines. By doing so, they allow users and turnkey systems vendors to produce a growing base of applications software that can be migrated among various systems without extensive modifications.

Bill Kaiser, Apollo's manager of CAD/CAE/CIM market development, commented, "More CAD vendors are realizing that in a market growing more competitive, users are not going to go with vendors that tie them into proprietary operating systems and networks. Manufacturing companies are starting to build impressive software bases in-house and are looking to try and link their own CAD applications into other areas of manufacturing such as manufacturing resource planning (MRP) and the factory floor. Vendors will have to provide for such future links."

Like IBM, Apollo realizes that value-added resellers are playing a larger role in providing CAD vendors with deeper distribution and market penetration into user markets, especially through vertical applications. One vendor especially successful in this area is Sun Microsystems, which was early to adopt Unix for its CAD products and encouraged users and OEMs to customise its systems. As a result, Sun has managed to capture 15% of the U.S. CAD technical workstation market after only two years in the business.

IBM's new aggressive CAD marketing strategy is also playing a major role in reshaping the CAD market. At the large systems end, IBM has started to intensify and broaden its CAD software offerings, using its installed base of 4300 series superminicomputers as the driving engines of its Cadam, Catia, Caeds and CBDS software programs. As the movement for the integration of CAD and MIS gains momentum, CAD vendors are feeling pressure from users to provide gateways for the interchange of graphics and design data between IBM CAD programs and their own CAD systems.

A good example is the CDS 5000 system from Computervision, a Bedford, Mass., CAD pioneer. The CDS 5000, based on an IBM 4300 computer, uses group technology software from the Organization for Industrial Research (OIR), a Waltham, Mass., subsidiary of Computervision. The system works with software that codes and classifies manufacturing components to create an elaborate parts design data base. From terminals, users can specify certain attributes of a part and receive data on what's in stock. They can also take a generic design of a part and specify characteristics such as length and diameter; they will then receive information from the data base on whether the design has already been done or whether a design can be standardized to use a part already in stock.

"Such a system, where group technology meets with inventory and work in progress, is the beginning of the interaction of MIS, CAD and CAM technologies," explained Bruce Jenkins, senior editor at Daratech, Inc., a Cambridge, Mass. research firm. "For IBM, it represents an opportunity for engineers and designers to see that IBM's data base management systems are truly premier; it also shows MIS departments that computer integration can start in their area. Companies like Computervision are also in a position to say, 'Look, we can use existing IBM computers to create a top-notch CAD system.' That means the user can get started on computer-integrated manufacturing at a fraction of the cost of dedicated high-end CAD systems."

The revolution IBM unwittingly started in the low-end, micro-based CAD market is already having a profound effect on the higher priced technical workstation segment. Two years ago, the low-end CAD market consisted mainly of dedicated technical workstations in the $25,000 to $50,000 range. That period was followed by one dominated by vendors that intended to use the IBM Personal Computer as a proficient, serious design tool with price tags below $10,000.

After initial resistance from CAD users, these predominantly IBM PC-based plain vanilla systems began to gain acceptance. Their first conquests were in the educational environment as CAD learning tools. Next, small AEC firms that could not afford multiple technical workstations saw these new PC-based CAD systems as an opportunity to gain a foothold in automated design. Shortly thereafter, large AEC companies also saw the benefits of some of these PC-based systems. Users were surprised to find that not only was PC CAD software inexpensive — generally between $500 and $1,500 — but many programs actually lived up to the performance claims of their vendors, especially those from the more successful California PC-based software vendors such as Autodesk, Inc., Personal CAD Systems, Inc. and Futurenet Corp. Larger AEC companies that had purchased large numbers of IBM PCs and were now at a loss as to how to utilize them found they could divert some machines to engineering and design departments to offload some of the front-end design burden from the larger CAD systems. Another advantage of PC-based systems was their ability to handle word processing and spreadsheet applications, which the larger, dedicated systems generally could not provide.

Based on sales, the most successful PC-based CAD software vendor is Autodesk. The company's Autocad software recently surpassed IBM's Cadam drafting package as the most-installed CAD software in the world, with installations expected to approach 23,000 by July. Since its introduction two years ago, Autocad has captured roughly 75% of the U.S. PC-based CAD market.

Software packages like Autodesk's Autocad, Personal-CAD Systems' Cadplan and Caddraft and Futurenet's Dash-1 Schematic Designer offer the ability to create; cut and paste; edit and revise; and store and retrieve professional drawings just like their more expensive CAD counterparts.

A cross section of Autocad's users is also indicative of the broadening customer base and use for such PC-based CAD systems. Boulton said Autocad users are about evenly divided among the mechanical engineering, electrical engineering and architecture fields. Uses range from developing contact lenses to designing Olympic bobsleds. One system is even working on the design for the next U.S. entry in the America's Cup Races. The size of companies represented by users also ranges widely, from freelance designers to organisations like Ford Motor Co., General Motors Corp. and other Fortune 50 companies. These large companies are using Autocad to download and upload drawings between IBM PCs and large CAD systems from vendors such as IBM and Huntsville, Ala.-based Intergraph, Inc.

Given the low cost of such PC-based systems, however, users cannot expect performance on the same standard as more expensive CAD systems. PC-based systems are still tied to the much slower processing and response times of 16-bit microcomputers. They are also standalone devices with nonexistent or very weak networking, multiuser and multitasking capabilities. Screen graphics resolution is generally around the medium 600 by 400 pixel range, and windowing, three-dimensional viewing and solids modeling — three major components of larger CAD systems — are still beyond the capability of most PC-based systems.

Vendors of PC-based systems, however, are working to rectify these limitations. Autodesk, for example, will soon introduce additions to Autocad called Advanced Drafting (AD) extensions. Although the basic Autocad package still sells for $1,000, the AD II extension adds mirroring and drag-in capabilities as well as isometric viewing for an extra $1,000. The AD III extension will also provide three-dimensional capability for an additional $500.

Some vendors are increasing the IBM PC's CAD power by adding an Intel 8087 coprocessor to handle floating point computation and increase design throughput. Others, such as Personal CAD Systems, Futurenet and Daisy Corp. of Mountain View, Calif., are further increasing the power of their programs by having them run on the IBM Personal Computer XT and Personal Computer AT, taking advantage of the XT's hard disk and the AT's faster Intel 80286 processor. Turnkey system vendor Hi-Tech Marketing Corp. of Wakefield, Mass., for example, has introduced integrated CAD systems based on the IBM PC AT, the IBM PC XT and the Nippon Electric Corp. APC3 microcomputer. Ranging in price from $2,000 to $30,000, the Hi-Tech systems can run both off-the-shelf and custom software. One Hi-Tech product can even produce numerical control code directly from design specifications, a feat that, according to the company, is usually handled only by systems that cost much more. Users are also purchasing add-on graphics boards from companies like Tecmar, Inc. and Hercules, Inc. to improve IBM PC graphics and resolution.

The IBM PC remains the primary engine driving the extreme low and of the CAD systems market, but other vendors are attempting to place similar CAD software on several IBM PC compatibles from companies such as Zenith Data Systems Corp., Texas Instruments, Inc., NCR Corp. and Compaq Computer Corp. as well as on the new flock of IBM PC AT compatibles. Other CAD programs — for example, the popular Cadapple from Versacad of Huntington Beach, Calif. — are appearing on Apple Computer, Inc. microcomputers and even machines running the CP/M and CP/M-86 operating systems.

This increased activity in the low-end CAD market has attracted larger CAD companies. Applicon, Inc., the Shlumberger subsidiary in Burlington, Mass., has introduced the Aria workstation, based on a 32-bit processor compatible with the Digital Equipment Corp. VAX/VMS operating system. An entry-level Aria system with 3M bytes of main memory and 160M bytes of off-line storage costs $80,000. Control Data Corp. of Minneapolis, Minn., has introduced a low-cost version of its high-priced Icem system. The new Icem Intelligent Workstation has a 32-bit processor with 2M bytes of memory expandable to 8M bytes, and 240M bytes of disk storage. A single workstation configuration with dual display costs from $86,000. Intergraph recently announced Micro II, a DEC Microvax-based four-workstation system priced between $40,000 and $60,000.

Still more competitively priced is Intergraph's $20,000 32-bit workstation, the Interpro 32. The workstation can operate either as a general-purpose computer running software under the Unix 4.2bsd operating system or as an IBM PC-compatible computer running programs under MS-DOS. Computervision seems to have been the first large CAD vendor to test the waters of the PC-based CAD market with the release last year of its Personal Designer package. Other large CAD system vendors will probably follow suit, especially in light of DEC's recent introduction of its $20,000 Microvax II desktop computer and rumors that IBM will soon introduce its own CAD workstation.

Statistics certainly bear witness to why vendors are becoming more interested in the microcomputer-based CAD market. International Resource Development, Inc., a research firm in Norwalk, Conn., is projecting the worldwide CAD market to climb from $2.1 billion in 1984 to $29 billion in 1994. Within this field, low-cost CAD systems — those generally below $80,000 — are expected to capture about 20% of total CAD revenues by 1986, translating roughly into a $800 million share of a $4 billion market. In contrast, low-cost CAD systems captured only 3% of the total CAD market in 1980.

Though PC-based CAD systems still accounted for only $60 million in 1984 U.S. revenues, Los Altos, Calif.-based Creative Strategies International, Inc. has predicted that by 1988 these systems will account for the lion's share of micro-based AEC installations, an area with an annual growth rate of 60% and no signs of flagging.

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FOCUS ON: TECHNOLOGY

JIT: What Is It? And How Does It Affect DP?

By Lee White

Winning the guessing game of supply versus demand in a manufacturing plant can all too often mean the difference between a large corporate profit or a large corporate loss. Tradition says that the safe bet is to have enough product in inventory to satisfy potential demand. Now, however, tradition is being challenged.

Manufacturing resource planning (MRP II) is complex systems software that can include materials requirements planning (MRP), production scheduling, inventory transactions, bill of material, purchasing, shop floor control, routing and work center identification.

At the other end of the process, no module exists to detail or control the manufacturing process itself. Enter Just In Time (JIT), a philosophy that has as its goal maintaining just enough material in just the right place at just the right time to make just the right amount of product. Guided by this philosophy (or mind-set), companies set a course to achieve the goal.

At the core of either MRP II or JIT is inventory. In the case of MRP II, the computer stores data that relates to inventory — inventory of raw material and inventory of finished product. Enough of both must be on hand to satisfy that elusive entity, demand. But there is another reason for the large amount of inventory and the accompanying need to use high-powered computers to store all data relating to it: poor quality. If some of the stored raw material is of poor quality, extra material must be on hand to serve as a substitute when the quality problem is detected. Similarly, at the other end of raw material is finished product. Excess finished product must be kept in inventory just in case questions arise about the quality of the finished product. Unfortunately, problems with raw material or finished product are usually not detected until the product comes off the last assembly line.

What made it difficult to detect these problems was that manufacturing facilities needed long production runs on machines to justify the time necessary to change over machines to make different products. The machine that turns out 26-inch bicycles may be the very same machine that manufactures 20-inch bicycles. That machine must be set up differently to run the smaller bicycles, however, and changeover may take two people four hours to accomplish the task. If that changeover time could be shortened — from four hours to 10 minutes, for example — significant saving could result. Instead of using the machine to make 10 26-inch bicycles each hour (a total of 80 26-inch bicycles daily), management could elect to make 20 each of 20-inch, 22-inch, 24-inch and 26-inch cycles daily (still a total of 80 bicycles). And if it were found that the bolts necessary to make the 22-inch bicycle were defective, a 10-minute changeover time would allow workers to make a different size bicycle while quality bolts were located for the 20-inch cycle.

Quick changeover or setup time is one of the most important components in a JIT environment. The technique began in Japan in 1957 in the setup operation at the Mitsubishi Heavy Industries shipyard in Hiroshima and resulted in marked improvement in the setup operation for a diesel engine bed planer. In 1969, management at the Toyota Motor Co. asked Shigeo Shingo, a noted Japanese consultant, to help them reduce the setup time of a 1,000-ton press. The setup time had already been cut from four hours to an hour and a half, and Shingo was able to further reduce the time to three minutes. The techniques employed to accomplish the feat resulted in a book entitled *The Toyota Production System*; this book became the bible of the JIT movement.

The U.S. company that has made the biggest splash with JIT is Omark Industries, Inc., in Portland, Ore., the world's largest manufacturer of saw chain. Larry White, plant manager, likened the shortened setup time to a pit stop at the Indianapolis 500 road race. "You know what? It'll work with anything," White enthused. "They don't have a huge investment to change those tires in five seconds, but they've got all the right equipment in all the right places. Everything's organized. Everybody knows what his job is and away they go."

It all began for Omark in 1980, when Jack Warne, Omark's president, observed JIT manufacturing in a Mitsubishi plant in Australia. Shortly thereafter, he and a group of executives from other companies went on a guided tour of Japanese factories with Norman Bodek, president of Productivity, Inc., in Stamford, Conn. On his return to Oregon, Warne organized a task force, and the company purchased 600 copies of Shingo's book.

In 1982, small study groups of managers, engineers, supervisors, secretaries, production planners, machine designers and inspectors reviewed the book. "What we were trying to do was to gain some understanding of the philosophy," White explained. Omark renamed the JIT system Zips (zero-inventory production system) and developed a three-pronged approach to implementation: Zips, total quality commitment and employee involvement.

Actual implementation of Zips was very basic. The plant manager was given a key to the room where inventory was housed. If a problem arose and more inventory was needed, workers had to justify their needs to the plant manager. If the plant manager agreed that a problem existed, he assigned "one more cupful of work-in-process," White said, "or just enough to tide you over until you have a little more time to fix the problem."

One of the teachings of JIT is that inventory must be viewed as evil. White compared excess inventory to water covering the rocks beneath the surface of a pond. "You can never see the rocks — or problems — until you lower the water — or inventory. You fix the problems and then lower the inventory some more, and then you fix that. It's a continual process of improvement."

In the first five months of Zips implementation, Omark reduced inventories by 50%. According to White, this 50% reduction translated into "double-digit millions [of dollars]" at the Portland location. A secondary result was savings in floor space. "We've now freed up well over 30% of our floor space at the same production level." This savings has let Omark use existing facilities to produce additional new products or additional volume in the same product lines.

Another critical tenet of JIT is establishing close relationships — personally and logistically — with vendors to reduce chances of defective inventory. In a large manufacturing company that does not practice JIT, the multivendor environment is the norm. When the time comes for a contract to be let, vendors' bids are requested and a group of vendors is selected. Relationships between manufacturer and vendor and between vendor and vendor become adversarial and quality may suffer. In a true JIT environment, awarding of bids is based primarily on quality and physical location of the supplier; the result is often a single-vendor situation.

The Nissan plant in Smyrna, Tenn., is a prime example of how well the single-vendor relationship can work in a true JIT environment. Although most of the manufacturing processes are heavily robotized, the trim and chassis plant is using JIT for seat procurement. The vendor is Hoover Universal, Inc., North American Seat Division, headquartered in Saline, Mich. When the Nissan plant was being built, bids were requested from seat manufacturers, with the understanding that the successful bidder would build a plant close to Nissan's location and provide seats for the trucks on an as-needed basis. According to Prince Reed, production control manager for Hoover in Murfreesboro, Tenn., orders for seats are sent from Nissan's computer to a printer in Hoover's shipping department. At the same time, the order information is sent to a robot, which goes to the rack and picks out the requested seats. Hoover's trucks leave its plant every hour and make the 18-mile trip to Nissan.

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Hoover is no stranger to JIT manufacturing. Reed said that his company is cooperating with auto makers all over the nation to fulfill their JIT requirements; he cited as examples General Motors Corp., Ford Motor Co., American Motors Corp. and Volkswagen of America, Inc.

Reed said that to his knowledge none of the contracts Hoover has with the various automobile manufacturers has been canceled. There is always the possibility that a low bid from another company could close the plant, he added, but continued good quality is Nissan's primary concern.

Another piece of JIT manufacturing is the linking or overlapping of subassembly operations. In a JIT shop, all the machines required to produce finished product are placed in close proximity, obviating the need for long-distance moves of work-in-process. Moving machinery is expensive and time-consuming, especially when it becomes a trial and error situation. "We're still moving machinery around. We're going to be spending on the order of half a million dollars this year moving machinery around one [Omark] plant," White said. Management at Omark has seen the dollar savings that result when a true JIT implementation is up and running and, as a result, is probably more understanding about expenditures of this sort.

Short setup times, overlapping subassembly operations and a small number of nearby suppliers may be the tangible hallmarks of successful JIT implementation, but consistent, thorough and sensitive employee training is the key to its success. Gerry Dorman is chairman and chief financial officer of Rath and Strong, a Lexington, Mass.-based management consulting group that specialises in MRP and JIT. He has seen problems develop when there is little flexibility in job definition. Another problem is individual incentives. "It's more difficult to put things into overlapping operations if people are used to an individual incentive," Dorman said. To overcome this problem, management often opts for group incentives. Dorman admitted that, because changes of this kind would fall into the category of change in working conditions, a manufacturing plant with union workers would have to negotiate the incentive system at contract time.

Before JIT ever hit the shop floor at Omark, most salaried workers had studied the concepts. The training has continued and White expects it to go on for about three years. "We're talking on the order of 40 hours of class time for every employee, every year — from president to janitor. It's a huge training investment," White said. The company is doing most of the training internally and has hired a professor from a Michigan university to teach statistical process control. "We didn't have anybody who had the teaching skill plus the technical knowledge to transmit that real dull boring statistics garbage. We found this guy who has the technical skill and he's a super teacher." Omark has contracted to employ the professor for 25 weeks each year, while the rest of the year he travels to IBM and other companies.

Set against each other, MRP and JIT seem outwardly antithetical. Al Lanick, consultant with Advanced Systems, Inc., a manufacturing training firm in Chicago, Ill., admitted that a controversy is raging over MRP and JIT. "There are people in the [manufacturing management consulting] industry who are racking up a lot of billable hours taking a position one way or the other, but I think you would find that most of them today say [MRP and JIT] can coexist," Lanick said. He added that changes need to be made and not every MRP application is going to be valid in a JIT environment, but corporations that have invested millions of dollars in manufacturing systems are certainly not moving away from computerization. Instead, they and their vendors are adopting a new philosophy on how to produce product. "This will require some tremendous changes in thinking and attitudes on the part of employees in those companies," Lanick concluded.

Dorman of Rath and Strong agreed that JIT does not obviate the need for MRP, referring to JIT as a philosophy and MRP as the systems and software. Dorman said the two are related; to consider the MRP/JIT question as a contest is "a false argument, or straw men at best."

As an example of the close relationship, Dorman mentioned the MRP module of shop floor control. In the pure MRP environment, the module might address three separate subassembly operations. In a manufacturing facility employing JIT, the three operations might be overlapping or linked and occur so rapidly that the result is one operation instead of three. In this case, data within the MRP software would be modified to reflect only one operation.

Standing witness to the peaceful coexistence of MRP and JIT is Omark Industries. Management at Omark has removed shop floor scheduling from the MRP system because Zips has solved that problem. Instead, MRP is being used for capacity planning, human resource planning and raw materials purchasing. What this reallocation has done is to free the mainframe for other on-line systems. "The problem with MRP is that it always runs in batch mode. If you run batch daily in a large operation, you're probably going to burn up two to four hours a day," White explained. All that has changed with the successful JIT implementation, Omark is now able to schedule daily, and process in batch weekly.

Although JIT has little if anything to do with computerization, Dorman stated there is a great need for management information systems professionals to understand the just-in-time environment. This is especially true for the analyst charged with the task of designing workable systems for the company, he added.

Whether a company uses MRP, JIT, a combination of both or neither, the days when American companies didn't have to worry about competition are gone for good, White said. "If you haven't improved, some other competitor is working on an improvement of the process, the design, the function of the part or a change to better suit the customer. The old saying, 'if it ain't broke, don't fix it,' just doesn't pertain anymore."

In spite of many recent articles in trade newspapers and magazines stating that the U.S. is fast becoming a service-oriented country and manufacturing is a dying industry, White disagreed in theory, and said he hoped such a shift would never occur. "If we aren't manufacturing anything, who in the hell is going to have any money to buy the services?" he asked. "One of my staff guys put it like this: If there isn't any manufacturing business left in the U.S. and there're only two jobs left, and one is shucking corn and the other one is selling insurance . . . ." White laughed.

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White is a senior writer at Computerworld Focus.

ALAN WITSCHONKE

Cadd/CAM Acquisition: Who's In Control?

By Joel N. Orr

The engineering manager, told that data processing is to head the computer-aided design and drafting system acquisition effort, does a slow burn. Or, in another company, the DP manager considers passive resistance when he learns that DP will be required to interface to whatever engineering buys but will have no say in the selection. Who should be in control?

Computer-aided design and drafting and computer-aided manufacturing (Cadd/CAM) systems are, of course, computer systems; their selection and management can therefore best be addressed by computer professionals. But engineering and manufacturing are often reluctant to involve DP in these activities because they see DP as an adversary.

Before deciding who should own the Cadd/CAM turf, it is important to understand what Cadd/CAM encompasses.

Computer-aided design and drafting: Cadd is a phrase that glues together two terms of very different scope. Drafting is the producing of drawings; design is the ordering of intentions. Drafting is the most common way of giving form to designs, much as typing is the most common way of giving form to writing.

All Cadd systems have certain components in common: A computer, a workstation with a graphics display and an input device, a graphics output device and Cadd software. Cadd systems range in size from desktop personal computers to the largest of mainframes, supporting hundreds of workstations. They can be centralized, like the IBM Cadam system; decentralized, like Apollo Computer's Auto-Trol systems; or a bit of both, like the Intergraph Co. system. Prices cover a wide range: on the low end, $7,200 for a tiny Apple Computer, Inc. Apple-based Robographics turnkey, complete with plotter; on the high end, millions of dollars for a large Control Data Corp. Icem system with dozens of workstations.

Most Cadd systems are not used for other functions; such use would have a negative effect on workstation response time, one of the most important ergonomic characteristics of a Cadd system.

Cadd and productivity: Computer-aided drafting is easy to cost-justify because drafting has a well-defined and measurable product; the benefits of computer-aided design, however, must be taken largely on faith. Small wonder that most of the 15,000 Cadd systems in use are made to function as drafting machines and that designers seldom use them. Drafting systems for most engineering disciplines are similar; they must all permit the rapid production of drawings. Electronic, mechanical and architectural drafting demand lines and curves, text and symbols, panning and zooming and so on — but to varying degrees. Design systems are application-oriented: Schematic capture systems must preserve topological continuity, but have little use to the creator of integrated circuits. It is also helpful for design systems to interface to application-specific analysis programs, which are seldom marketed by the Cadd system vendor.

Drafting systems are usually operated by dedicated operators expert in their use. Design systems — and relatively few Cadd systems are used this way — are available to designers on an as-needed or casual basis. These arrangements make it easy to measure the productivity of a drafting system and almost impossible to do the same for a design system.

Computer-aided manufacturing: CAM is a term that can legitimately be applied to a wide variety of applications: numerical control, robotics, manufacturing resources planning, computer-aided process planning and many others. CAM predates Cadd.

CAM and productivity: Automating the factory is generally more fruitful than automating the engineering office; each gain in efficiency is multiplied by the volume of production. Furthermore, manufacturing personnel are much more accustomed than design personnel to dealing in measurables. Identification and achievement of productivity gains are therefore much easier in the factory than in the design office.

Cadd/CAM: The greatly heralded

productivity gains of industrial automation can be realised only through integration of design and production automation. The key to this process is the geometric description of the product design, which must originate with engineering. Electronic transfer of the completed design to manufacturing and electronic feedback from the manufacturing process to engineering can eliminate communication delays and opportunities for the introduction of errors.

Computer-integrated manufacturing: CIM departs from the traditional view of manufacturing in the U.S. It involves using computers to automate the entire manufacturing process in an integrated form, rather than mirroring the historical separation of engineering and manufacturing. In general, the U.S. lacks a map for moving from Cadd/CAM to CIM, although the idea is popular.

Whose turf?: The problem of ownership has several layers. Cadd is largely the province of engineering; CAM involves manufacturing. Engineering and manufacturing often find themselves at odds with each other because they work toward conflicting objectives: Engineering wants to perfect the design; manufacturing wants to get it (the product) out the door. DP, on the other hand, has often lost the trust of both engineering and manufacturing by mismanaging their expectations. Computer professionals, viewed as empire-builders who care nothing for the real needs of users, are therefore excluded from Cadd/CAM system acquisition and implementation decisions.

It's also true, however, that DP personnel commonly feel frustrated by engineering and manufacturing management's apparent lack of willingness to recognise the need to invest in training and automation, although they may be expending large sums on factory and office equipment and buildings that offer far less productivity leverage.

Objective obstacles also exist. Most DP installations in manufacturing companies are highly centralised IBM affairs. Cadd applications, because they require large message and buffer sizes and extremely fast system response, place enormous demands on computers. Installing Cadd in the central computer system causes system responsiveness to drop at a rate out of proportion to the number of users added. The drop leads in turn to the acquisition of additional CPUs and a very high cost per "seat" for Cadd.

Cadd systems require exotic peripherals — graphics workstations, plotters and digitisers — with exotic interfacing demands. Few DP departments are equipped to assist end users in the selection and installation of this type of equipment. In addition, most of these strange peripherals were designed for the minicomputer environment, not the centralised DP milieu. They typically speak Ascii, not Ebcdic; they look like teletypes, not Systems Network Architecture (SNA); and they usually require operator expertise for smooth operation.

Another trend keeping Cadd out of the computer room is the growth of microcomputer Cadd systems. Dozens of computer-aided drafting products are now available for desktop microcomputers — products functionally equivalent or superior to many of the older mini- and mainframe-based drafting packages. Although larger computers are still required for such computer-intensive functions as solids modeling and finite element analysis, most of the 20,000 mini- and mainframe-based Cadd systems in use are functioning purely as electronic drafting boards — at an average per-seat cost of more than $100,000. A complete micro drafting system — including hard disk, graphics input device, medium-resolution (480- by 640-pixel) color graphics display and small pen plotter — can be had for $10,000. And these small units can be networked.

Engineers who buy computers without the assistance of DP professionals often do so at the cost of recreating in miniature all of DP management's hard-learned lessons — the importance of backups by losing data, the frustration of device incompatibilities by not setting and imposing standards and the need for security and formal record management procedures by having valuable designs leave the premises with a fired employee.

It takes time for engineers to learn why private data bases are not good for the company and why the device that costs least in the short term often winds up costing most in the long term. By the time they learn these and other lessons, they have gone too far simply to admit their mistake and invite DP to help. The result is new mini-DP departments doomed to repeat all the errors DP itself committed in the '50s and '60s.

Cadd/CAM may not belong in the computer room, but the Cadd/CAM implementation process does need the participation of DP professionals. DP should take the initiative in bridging the existing communication gap with engineering and manufacturing by:

- Assigning personnel to learn both Cadd/CAM technology and the needs of engineering and manufacturing.
- Offering education, information and cooperation to the engineers.
- Working toward changing the situation from one that pits DP against the engineers to one that pits "our" company against the flood tide of technology.

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Products

CDS II

BEDFORD, Mass. — **Computervision Corp.** has announced Phase II of its Computervision Distributed System (CDS), a network of central host-based systems and remote engineering workstations for the manufacturing industry.

CDS II uses an industry-standard Ethernet-TCP/IP network architecture and Computervision's Fastlink communications link, a 10K-byte/sec file transfer bridge between a Computervision CDS 4000 computer and Digital Equipment Corp. VAX computers.

According to the vendor, its Communications Concentrator can simultaneously connect up to six remote intelligent workstations to a host server CDS 4000 through the TCP/IP architecture.

Systems that Computervision said could be integrated with CDS II include Computervision's Personal Designer software running on an IBM Personal Computer XT or Personal Computer AT; and Digital Equipment Corp. VAX-based systems running Medusa, as well as others.

Prices for the CDS II system can run from $30,000 to $2 million, depending on the configuration. For further information, contact Computervision Corp., 15 Crosby Drive, Bedford, Mass. 01730.

BURLINGTON, Mass. — **Matra Datavision, Inc.** has announced its Series 50 computer-aided design (CAD) workstations, which, according to the vendor, allow users to tailor the workstations to their specific CAD requirements. The Series 50 workstations use Motorola, Inc. 68000 processors with 1M byte of main memory and offer direct memory access of 2M bytes to increase throughput speed.

Matra Datavision also introduced Euclid Turbo 3D/2D, a software package aimed at providing a smooth transition from three-dimensional solids modeling to two-dimensional drafting applications.

Prices of the Series 50 workstations start at $40,000. The Euclid Turbo 3D/2D package is priced at $60,000. For further information, contact Matra Datavision, Inc., Corporate Place 1, 99 S. Bedford St., Burlington, Mass. 01803.

MINNEAPOLIS — **Honeywell, Inc.** has introduced its Plant Management System, designed to improve production management, energy consumption, product quality and product yield. According to the vendor, the system permits on-site production scheduling, maintenance management and material management and storage.

The system also enables customers to link their off-site Honeywell or non-Honeywell corporate computer systems, giving on-line plant data to company planning and administration areas.

Honeywell also introduced the Work Center Controller 1250 from Honeywell's **Digital Datacom, Inc.** subsidiary located in Long Beach, Calif. The controller automates the collection and processing of data on work in progress, inventory, maintenance scheduling and quality assurance and testing.

A full-scale Plant Management System ranges in price from $750,000 to $1 million, excluding license fees for selected applications. The desktop Work Center Controller 1250 is priced at $10,000. The floor or rack-mounted versions range in price from $30,000 to $100,000.

For further information, contact Honeywell, Inc., Honeywell Plaza, Minneapolis, Minn. 55408.

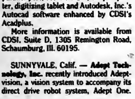
LOWELL, Mass. — **Wang Laboratories, Inc.** has introduced its Engineering Support System, a system combining the Wang PIC workstation and Autocad, a computer-aided design (CAD) package from Autodesk, Inc. of Sausalito, Calif.

The PIC workstation is priced at $15,935; Autocad is priced at $2,000. For further information, contact Wang Laboratories, Inc., One Industrial Ave., Lowell, Mass. 01851.

SCHAUMBURG, Ill. — **Cad Design Systems, Inc.** (CDSI) has introduced a turnkey computer-aided design (CAD) system that retails for under $10,000. Cadstation includes an IBM Personal Computer with high-resolution graphics monitor, 640K-byte random-access memory, 10M-byte Winchester disk drive, 360K-byte disk drive, 8087 math coprocessor, two RS-232 serial ports, one parallel port, MS-DOS 2.1, six-pen plotter, digitizing tablet and Autodesk, Inc.'s Autocad software enhanced by CDSI's Acadplus.

More information is available from CDSI, Suite D, 1305 Remington Road, Schaumburg, Ill. 60195.

SUNNYVALE, Calif. — **Adept Technology, Inc.** recently introduced Adeptvision, a vision system to accompany its direct drive robot system, Adept One.



Adeptvision

Adeptvision is completely integrated with the Adept One robot and operates from the same controller, thus eliminating interface problems, according to the vendor. The vision enhancement can recognize either stationary parts or those on moving conveyors. Adeptvision can also reportedly identify touching or overlapping parts.

The price of the robot averages $40,000, depending upon options; Adeptvision adds $17,000 to the price. For more information, contact Adept Technology, Inc., 1212 Bordeaux Drive, Sunnyvale, Calif. 94089.

MAYNARD, Mass. — **Digital Equipment Corp.** has introduced the Microvax II system based on DEC's "VAX-on-a-chip" processor, the Microvax 78032. Also introduced was the Vaxstation II graphics workstation based on the new very-large scale integration processor.

The Microvax II will reportedly run all VAX software and give VAX 11/780-level performance at a fraction of the cost, DEC said. Four Microvax II systems will be offered, ranging from an $18,840 single-user model with 2M bytes of main memory and a 31M-byte hard disk drive to a $43,780 16-user system with 5M bytes of main memory, 213M bytes of disk storage and a 95M-byte streaming cartridge tape drive.

The Vaxstation II workstation based on the Microvax CPU offers 2M bytes of memory, bit-mapped video graphics, a 19-in. monochrome monitor, dual floppy disk drives, a 31M-byte Winchester disk drive and MicroVMS software. It is priced at $26,500. The two machines will replace, for the most part, the Microvax 1 and Microvax I-based workstations, DEC said. The new products are targeted for the engineering, commercial, education and computer graphics market.

For additional information, contact Digital Equipment Corp. in Maynard, Mass.

SAUSALITO, Calif. — **Autodesk, Inc.** recently announced that Autocad, its microcomputer-based computer-aided design (CAD) software, has been linked with IBM's mainframe-based Cadam via a translator developed, sold and supported by Cadcor of Mountain View, Calif.

According to the vendor, Cadam/Autocad Translator will allow engineers to work at personal computer-based engineering workstations that run not only Autocad but also programs such as Lotus Development Corp.'s 1-2-3 and Symphony, Ashton-Tate's Dbase III, Microsoft Corp.'s Word and Micropro International Corp.'s Wordstar. Autocad drawings can reportedly be transferred to and from the centralized Cadam data base on the host.

Translation is accomplished through a Fortran program on IBM 4300 or 3080 mainframes operating under VM or MVS. Communication between Autocad and Cadam is accomplished via an IBM 3270 coaxial connection or serial asynchronous Ascii transmission.

Cadam/Autocad Translator costs $10,000 per Cadam site and $200 per Autocad workstation.

For more information, write to Cadcor, 175 E. Dana St., Mountain View, Calif. 94041.

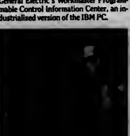
IRVINE, Calif. — **McDonnell Douglas Computer Systems Co.** has announced a manufacturing control software package designed to run on its own Microdata M4700, M6320, M6525, M9100 or M9208 minicomputer systems.

Called the Manufacturing Management and Control System (MMC), the system consists of the following modules: Engineering, Sales Order Processing, Master Production Scheduling, Work in Process Costing, Shop Floor Control, Standard Costing, Inventory Planning, Purchasing, Work Order Launching, Accounts Receivable, Accounts Payable, Payroll and General Ledger. The modules may be purchased separately or as a total package.

MMC is reportedly a fully-integrated, on-line system designed to accommodate companies with 50 to 800 production workers. The one-time license fee ranges from $2,500 to $37,500, depending upon the combinations of modules chosen and the Microdata computer on which the system runs.

For more information, contact McDonnell Douglas Computer Systems Co., 17481 Red Hill Ave., Irvine, Calif. 92714.

SCHENECTADY, N.Y. — **General Electric Co.** has demonstrated Modelmaster, its factory simulation software that runs on IBM Personal Computers, IBM Personal Computer compatibles and General Electric's Workmaster Programmable Control Information Center, an industrialized version of the IBM PC.



Modelmaster

According to the vendor, Modelmaster creates realistic representations of factories or parts of factories complete with icons that resemble robots, forklift trucks and so on.

To model a factory with Modelmaster, the user interacts with the computer using a typewriter-like terminal and a graphics tablet with a mouse input device. The vendor claimed the typical manufacturing engineer can learn to use the system in half a day. Shipments of Modelmaster are expected to begin in the third quarter of 1985.

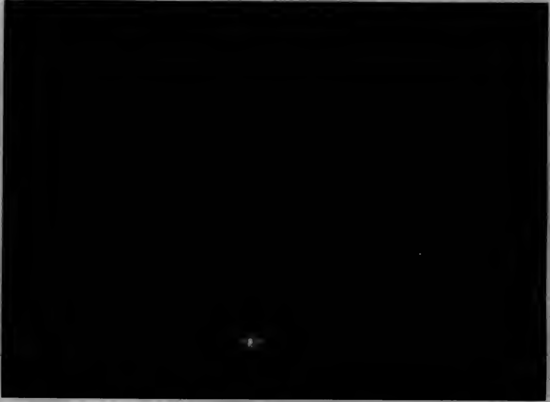
For further information contact the General Electric Research and Development Center, P.O. Box 8, Schenectady, N.Y. 12301.

BURLINGTON, Mass. — **Applicon, Inc.** has introduced Aria II, a family of advanced 32-bit engineering workstations designed for the technical professional.

The Aria II uses the newly announced Microvax II processor boards manufactured by Digital Equipment Corp. The workstations include 3M bytes of memory and a 160M-byte disk drive for mass storage, as well as Applicon's Bravo data base management and user interface capabilities.

Aria II workstations also have a 22 in. by 27 in. by 36 in. processor module with a hardware floating point accelerator and MicroVMS operating system. The workstations are available with a choice of 13-in. or 19-in. displays.

Aria II will be available in July 1985, the vendor said, at prices ranging from $99,000 to $125,000. For more information, contact Applicon, Inc., 32 Second Ave., Burlington, Mass. 01803.



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June 20-21, Santa Clara, Calif. — **Dataquest Focus Conference.** Contact: Dataquest, Inc., 1290 Ridder Park Drive, San Jose, Calif. 95131.

June 24-26, San Francisco — **IBM Teleprocessing Software: Structure, Systems and Applications.** Contact: Seminar Department, Datapro Research Corp., 1805 Underwood Blvd., Delran, N.J. 08075.

June 24-26, Dallas — **Introduction to Data Communications.** Also, July 1-3, Boston; July 10-12, Washington, D.C.; July 24-26, New York; and July 24-26, San Francisco. Contact: Systems Technology Forum, 9000 Fern Park Drive, Burke, Va. 22015.

June 25-27, Phoenix — **Dataquest's Annual Computer Storage Industry Conference.** Contact: Dataquest, Inc., 1290 Ridder Park Drive, San Jose, Calif. 95131.

June 26-28, Dallas — **The Integrated Voice/Data PBX: Architectures and Products.** Contact: Technology Transfer Institute, 741 Tenth St., Santa Monica, Calif. 90402.

June 27-28, New York — **Networking, Protocols and Compatibility.** Contact: Seminar Department, Datapro Research Corp., 1805 Underwood Blvd., Delran, N.J. 08075.

June 27-28, San Francisco — **IBM's SNA: A Master Plan for Teleprocessing and Data Communications.** Contact: Seminar Department, Datapro Research Corp., 1805 Underwood Blvd., Delran, N.J. 08075.

June 27-28, New York — **Telecommunications I: An Introduction to Voice Communications.** Contact: Seminar Department, Datapro Research Corp., 1805 Underwood Blvd., Delran, N.J. 08075.

July 10-12, Hyannis, Mass. — **Toward Knowledge-Based Systems: Information for Decisions.** Contact: Information Industry Association, Suite 400, 316 Pennsylvania Ave., Washington, D.C. 20003.

July 15-17, Los Angeles — **Local-Area Networks.** Contact: Systems Technology Forum, 9000 Fern Park Drive, Burke, Va. 22015.

July 15-18, Chicago — **1985 National Computer Conference.** Contact: Afips, 1899 Preston White Drive, Reston, Va. 22091.

July 22, Seattle — **Strategic Management Planning.** Contact: Software Institute of America, Inc., 8 Windsor St., Andover, Mass. 01810.

July 23-25, Seattle — **Logical and Physical Design.** Contact: Software Institute of America, Inc., 8 Windsor St., Andover, Mass. 01810.

July 29-August 2, Norfolk, Va. — **1985 World Conference on Computers in Education.** Contact: Afips, 1899 Preston White Drive, Reston, Va. 22091.

August 13-15, Boston — **Computer Graphics '85.** Contact: National Computer Graphics Association, P.O. Box 3412, McLean, Va. 22103.

August 26-29, San Francisco — **Intech '85.** Contact: Network Users Association/Intech '85, Suite 400, 2111 Eisenhower Ave., Alexandria, Va. 22314.

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